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The expert system virtual ophthalmologist

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Abstract

The article is dedicated to creating expert systems in the field of ophthalmology. "Virtual ophthalmology" is a Practice-Based Diagnostic Expert System covering the initial diagnostics of outpatient patients in the field of ophthalmology expert systems The adjustment of time series of tax revenues and relevant computer simulation of them was conducted by the fuzzy numbers according to the expert evaluation.

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1. Introdcution

One of the efeective fields of application of the Expert systems which are one of the successfully developing directions of Artificial Intelligence is Medical diagnostics. The attention to the field of diagnostics to create the Expert systems is result of the thoretical complexity of the problems in this field and their application significance.

The medical diagnostic Expert systems allow to draw a conclusion on the base of the possible errors (patient compliants) and to diagnose. The article is dedicated to commenting on the functionalization principles and realization steps of the Expert systems of initial diagnostics of outpatient patients in the field of ophthalmology.

The “Virtual ophthalmologist” is the diagnostic Expert system of practical purpose covering the initial diagnostics of outpatient patients in the field of ophthalmology. The analysis of the system shows that the knowledges collected from its knowledge base completely cover the subject area and the system chooses the more effective methods of solution, taking into consideration the disadvantages of the systems available in this field that is resulted in the more effective adaptation of the systrem to the reality, one of the most attractive aspects in the analysis of the “Virtual ophthalmologist” is as satisfactoction of its indexes of efficiency, as the simplicity of organizationb of interface unit and the convenience and clarity of user-system dialog.

The “Virtual ophthalmologist”, as an example of the Expert system of diagnostcal and practical purpose is developed on the base of modern computing texhnology and successfully tested in the ambulatory conditions. The patient compliants are learned and clarified in the registry, the clinical history is collected, the objective examinations (visual acuity, visual field, eye examination with focal lighting, reflection and plain ophthalmoscopy, definition of refractive eye, biomicroscopy, palpation and instrumental measurement of intraocular pressure, binocular vision examination, ultrasound examination of the eye, etc.) in the specific sequence are done and as a result of the examinations the informative data on the functional state of each patient’s eyes are collected. On the base of the data entered into the computer an outpatient patient is diagnosed with an initial diagnosis. The created software complex helps to keep pace with the patient's history as well. Additionally, this software complex provides the physician with the opportunity to get full information on the functional status of the patient, including the date of the disease history.

In the Expert system, established as an expert system for the initial diagnosis of outpatient patients, the organization of mechanism of extracting for clear interpretation of the plan and method of solution is described.

The system software is based on the principle of module. A graphical interface that provides convenient and convenient communication to unprepared users is commneted here as well. The created software is dedicated to the application of the research prototype and activity analysis of the Expert system. The results are specifically analyzed on a specific eye disease group-glaucoma. Separate diagnostic results of the software package and the doctors group are evaluated by physicians and the results are compared visualizing in diagrammatic form. The assessment of the experimental system and the acquisition of knowledge “to manage of out-of-eye disorders” is designed to help the housewife and nurse to diagnose the out-of-eye disorders. This system can be used by experienced physicians or users who have complained of the eye.

2. Formal description of the proposed methodology

The software complex in the System provides the following:

1. The database consists of a catalog of illustrations belonging to the subject area;
2. Provides work with graphic images taken from the device: entering the image and writing them into a database; Storage of text, graphic files and signatures; Search of images for given restrictions; View descriptive sequence; The scale of the image.
3. Keeping data in the database; Cardboard about the patient; Link between chart and graphic description.
4. Maintaining the medical reference of the patalogy in the database (medical illness section).

The software complex consists of 5 programs:
1. The program of nosology-structured image catalog
2. Descriptive work program for physician-researcher
3. Work program for the practicing physician
4. Software for the presentation of multimedia presentation
5. Software for reviewing multimedia software.

Knowledge is entered into the system by the expert in the form of rules (meta-cades). The components of the antecedent of the rules are made up of facts only. The basic principle in the rules is to execute what order is currently executed. In other words, the components of the antecedent of the rule are made up of both facts and metacades. In order to describe the structure of the rules in the subject matter area, we look at Knowledge Base, which identifies the congenital glaucoma, using the principle "IF... THEN...".RULES. Fragment of knowledgebase of the system is given below:
THE RULE SIM 1
IF THE PATIENT IS IN THE AGE OF 6 MONTHS – 12 YEARS AND VISION IS DECREASED AND THE FRONT CAMERA IS DEEP THEN THE META-RULE IS SIM1

THE RULE SIM 2
IF THE EYE IS AFRAID OF POOR EYESIGHT (PHOTOPHOBIA) AND IF EYE IS IRRITATING AND IF THE HORN IS EDEMA AND IF THE FRONT CAMERA FLUID IS TRANSPARENT AND IF THERE IS NO COMPROMISE THEN THE META-RULE IS SIM2

THE RULE SIM 3
IF THERE IS NAUSEA IN THE ABDOMINAL CAVITY AND IF THE SENSITIVITY OF THE CORNEA IS ATROPHY AND IF THE VISION NERVE IS PERIPAPILLIAR ATROPHY THEN THE META-RULE IS SIM3

THE RULE SIM 4
IF THE BINDING SHAFT IS IN THE UPPER EXTREMITY AND IF THERE IS NO CLAMPING THEN THE META-RULE IS SIM4

THE RULE SIM 5
IF THE VASCULAR UNIT HAS CHANGED ITS LOCATION IN THE HST AND IF THE PATHOLOGY IS EXCAVATION AND IF THERE ARE VEIN CHANGES IN THE EYE AND IF THERE IS NO ABORTION THEN THE META-RULE IS SIM5

The indicated qauda glaucoma is only one of the group diseases that has been identified to diagnose diarrhea of glaucoma. The knowledge base of the Expert system for the initial diagnosis of outpatient patients is based on the above-mentioned method. Thus, in the group of 10 eye diseases studied, individual peculiar features of each eye disease were taken into account.

Implementation of the problem in the expert system is carried out through the management components. The task of the management components is to ensure the functionality of the system under similar circumstances.

In the Expert system, the main differences between the control elements and the traditional control mechanisms are as follows:

1) is called for the description of the situation rather than the name of separate modules;

2) The connection between modules is formed in the process of solving the problem (as the next selected module depends on the current situation and is not formed in advance).

In order to find a solution in the Diagnostic Expert System, Tanimoto's formula is used to reduce the number of search engines.

$$S_{ij} = \frac{n_{ij}}{n_i + n_j - n_{ij}}$$

First, according to the patient's known symptoms, the possible "incidence" of the possible disease is determined, and then the "similarity" coefficient is calculated between it and the model of each known illness. Here n_i and n_j -

respectively, the amount of existing symptoms in i and j objects; n_ij - is the amount of symptoms simultaneously available for i and j objects (pricing "yes" and "no"). This formula requires that the indicators have two values ("yes" - "no"). For a diagnosis of a glaucoma patient, let's apply the Tonimoto formula in the medical diagnosis. Here, after determining the number of similar traits, the Tonimoto formula is applied,

For congenital glaucoma $S_{ij} = \frac{0}{10+0-0} = 0$

For angled glaucoma $S_{ij} = \frac{0}{10+0-6} = \frac{3}{7} = 0,42$

For glaucoma suspicion $S_{ij} = \frac{6}{10+6-6} = \frac{3}{5} = 0,6$

The values are found. The most commonly diagnosed "similarity" coefficients are the diagnosis and the other high-priced patients are described in a similar diagnosis list. Thus, the screened suspicion of glaucoma as a major diagnosis in the patient and a list of similar glaucoma and other similar diseases appear in the list of similar diagnoses .

The system's operating modes are based on the software module. These modules can be used at any time to get information about the patient, enter the symptoms of the patient, diagnose, edit data, search for the information in the database, make decisions, display the illness and screen anxiety and so on. Allowing.

The Diagnostic module, which implements the mechanism of extracting the software of the Expert system under consideration, is to diagnose patients. In the programming process, the "First Class" components package, APIs (Application Programming Interface), SQL (Structured Query Language), InnoSetup (installation software), and ChmBuilder (software for help system creation) were used as the additional components, libraries and language means.

3. Computer simulation

This work is devoted to the production system based approaches of knowledge representation. The production system has large applications in decision making problems(Aliev(2004,2012), Aliev(2010), Abdullayev(2006)). The user of the system may define new linguistic values, modify built-in ones and explicitly prescribe a membership function in any place where linguistic values are useful. The fuzzy if-then rules have the following form:

$$R^k : IF\ x_1\ is\ \tilde{A}_{k1}\ and\ x_2\ is\ \tilde{A}_{k2}\ and\ ...\ and\ x_m\ is\ \tilde{A}_{km}\ THEN$$
$$u_{k1}\ is\ \tilde{B}_{k1}\ and\ u_{k2}\ is\ \tilde{B}_{k2}\ and\ ...\ and\ u_{kl}\ is\ \tilde{B}_{kl}, \quad k=\overline{1,K}$$

where $x_i, i=\overline{1,m}$ and $u_j, j=\overline{1,l}$ are total input and local output variables , $\tilde{A}_{ki}, \tilde{B}_{kj}$ are fuzzy sets, and k is the number of rules. Note, that inputs $x_1, x_2, ..., x_m$ may be crisp or fuzzy variables.

The basic steps of the used inference algorithm proposed by Aliev(1994) is given below:

1. The truth degree of the rule is computed as:

$$r_{jk} = Poss(v_k / a_{jk}) \cdot cf_k$$

$$\tau_j = \min(r_{jk})$$

2.First the objects are evaluated, i.e. every w_i object has appropriate linguistic value defined as (v_i, cf_i). where v_i is linguistic value, $c_{f_k} \in]0,100]$ is confidence degree of the value v_i. v_k - linguistic value of the rule object, a_{jk} - current linguistic value (j is index of the rule, k is index of relation) value(for example , A_ir)

3. For each rule, calculate $R_j = (\min_j r_{jk}) * CF_j / 100$, where CF is the confidence degree of the rule.

4.The user or the creator of the rule defines the firing level (π) and $R_j \geq \pi$ is checked. If the condition holds true, then the consequent part of rule is calculated.

5. The evaluated w_i objects have S_i value: $w_i, (v_i^1, cf_i^1), ..., ..., (v_i^{S_i}, cf_i^{S_i})$ S_i is the number of the rules in

fuzzy inference process
6.The average value is determined as follows:

$$\bar{v}_i = \frac{\sum_{n=1}^{S_i} v_i^n \cdot cf_i^n}{\sum_{n=1}^{S_i} cf_i^n}$$

Algorithm is realized by ESPLAN expert system shell.

Above mentioned rules have been extracted from experts' knowledge based on interviews conducted by us.
In rules value of fuzzy variable is described by trapezoidal fuzzy number and linguistic terms are given below:
less than A: $(0, I, A - Z, Z)$
approximately: (Z , A , A , Z)
more than a: $(Z , A + Z , S , 0)$
neutral: $(Z , I , + 2Z , I + 3Z , Z)$
much: $(Z , S - Z , S , 0)$
etc.,
where I and S are respectively minimum and maximum values of universe, Z=(S-I)/5.

For example, fragment of basic objects and linguistic value of the term given below:
Obj(age, "age", 1,12,"year")
Obj(vs, "vision",0,1,"level")
Obj(ph, "photophobia",0,1,"level")
Obj(irtg, "irritating",0,1,"level")
Obj(fluid, "fluid",0,1,"level")
age level or less than A : $(0, I, A - Z, Z)$;
vision decrease or approximately A : (Z , A , A , Z);
photophobia level high or more than a = $(Z , A + Z , S , 0)$;
irritating level or high = $(Z , I , + 2 * Z , I + 3* Z , Z)$;
fluid trasprance *or much* = $(Z , S - Z , S , 0)$

The above mentioned model is implemented by using the fuzzy expert system ESPLAN by developed Aliev(2001) and different tests are performed. Different current information in tests is used.

Test 1: IF age is less than 6 and vision is approximately 0.5 and front camera is deep THEN type of disease=?
ANSWER: EXPERT system shell ESPLAN's decision is type of disease is **Congenital Glaucoma**.
Test 2
IF photophobia level is high and irritating level is high and the horn is edema and the front camera fluid is transparent THEN type of disease is disease=?
ANSWER: EXPERT system shell ESPLAN's decision is type of disease is **Glaucoma Suspicion**

Conclusion

As a result of the information analysis of the ophthalmology area and user surveys, the database conceptual scheme is drawn up. In an outpatient setting, preliminary data is collected, database with a relay model is implemented. For the initial diagnosis of outpatient patients in the ophthalmology, the knowledge is accumulated with the help of experts, the rules of the extracts based on the production model are formed and the knowledge base is created. A logical exclusion mechanism is established, taking into account the characteristics of diagnostics in the ophthalmology field, the methods of organizing data and knowledge bases and their relationships. In addition to the main diagnostic function of the generated expert system, the software complex has been developed, which also performs additional functions such as documenting the illness dates and creating electronic versions, collecting information about ophthalmic drugs, establishing an ophthalmic electronic dictionary and providing users with information-reference services . For estimation of type of disease fuzzy rules base model is suggested. For implementation of the suggested model, expert system ESPLAN is used. Experimental investigations show the validity and applicability of the suggested model and reasoning system. An expert system for the initial diagnosis of outpatient patients on ophthalmology has been applied in the VI Eye Diseases Department of Baku Clinical Hospital as a research prototype and has demonstrated the proper functionality

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