Cold-Heat Diagnosis System for Selection of Suitable Daily Meals Using Fuzzy Logic

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Abstract:

According to the Oriental Medicine, a health is the balance between Yin and Yang, vital energy and blood etc. Loosing the balance between Yin and Yang, one gets a disease. In syndrome differentiation of Traditional Oriental Medicine, Cold belongs to the category of Yin and Heat of Yang, therefore the Cold and Heat states of patient are basic syndromes which play a principal role in diagnosis and treatment according to the traditional oriental medicine. In this paper, we apply fuzzy logic for development of the system for diagnosis of Cold-Heat states and advice in therapy according to Traditional oriental medicine. We also describe the consultation system for diagnosis and treatment of Cold-Heat states.

Keywords:
Cold-Heat diagnosis, fuzzy logic, daily meals.

Introduction

Nowadays, the combination of Occidental and Oriental Medicine for diagnosis and treatment plays an important role in the health care for many countries in the world because this combination often results in the best diagnosis and treatment of Oriental medicine into Occidental medicine [1].

In recent years, there was a number of applications of fuzzy set theory and fuzzy logic in Oriental traditional medicine. Fuzzy set theory and fuzzy logic are helpful mathematical tools for managing uncertainty in medical diagnosis and treatment [2,3,4,5,7,8,9,10,11].

In this work we intend to analyze the standardization of Cold- Heat diagnosis for meals selection and Herbal Plant utility. This paper is to present an approach to applying the approximate reasoning for rule-based compositional system for Cold- Heat diagnosis using in standardization of meals selection and herbal plant utility. The organization of the paper is following: Section 2 describes the diagnosis process of Cold- Heat for meals selection in Oriental medicine using ConormMin compositions of rules as an inference mechanism model of the Cold- Heat expert system. Section 3 describes the implementation of Diagnosis Support System and finally, some conclusions are given.

COLD-HEAT Diagnosis Model for Meals Selection

Based on the inference features above, we propose a model of approximate reasoning for rule- based compositional system for Cold – Heat diagnosis using in standardization of meals selection and herbal plants utility of Oriental Traditional Medicine.

Let $S=\{S_1, S_2,.., S_n\}$ denotes the set of symptoms. Symptoms S_i take values μ_i in [0,1]. Values μ_i indicates the degree to which a patient exhibits symptom S_i where $\mu_{si}=1$ means symptom S_i surely present for patient P_q.
$\mu_{si}=0$ means symptom S_i surely absent for patient P_q, symptom S_i takes value μ_{si} in (0,1) means possible hypothesis of presence of symptom S_i for patient P_q and value $\mu_{si}=\varepsilon$ means that symptom S_i is undefined (ε takes a value closing to 0).
Let $E=\{E_1, E_2,.., E_n\}$ denotes the set of all elementary conjunctions of symptoms, conjunction of some symptoms and some other negated symptoms. Computing the weight of E_i using truth functions of fuzzy logic over [0,1]: $NEG(x)=1-x$ for negation, $CONJ(x,y)=\min(x,y)$ for conjunction.
Let $CH=\{C_1, C_2,.., C_n,H_1, H_2 ,..,H_n ,CH_1, CH_2 ,..,CH_n\}$ denotes the set of pathogenesis labeled with Han-Nhiet (CH) including syndromes Cold(C), Heat(H) and Mixed Cold- Heat (MCH). Pathogenesis labeled with Han- Nhiet CH take values $\mu^c_{PCH}(P_q,C_j)$, $\mu^c_{PCH}(P_q,H_j)$, $\mu^c_{PCH}(P_q,C_j)$, $\mu^{tot}_{PCH}(P_q,C_j)$, $\mu^{tot}_{PCH}(P_q,H_j)$, $\mu^c_{PCH}(P_q,CH_j)$, where the values $\mu^c_{PCH}(P_q,C_j)$ confirms Cold state, $\mu^c_{PCH}(P_q,H_j)$ confirms Heat state, and $\mu^c_{PCH}(P_q,CH_j)$ confirms Mix Cold- Heat state by patient P_q from the observed symptoms. The values
$\mu^{tot}_{PCH}(P_q,C_j)$ is total degree for confirmation of Cold C_j, and the values $\mu^{tot}_{PCH}(P_q,H_j)$ is total degree for confirmation of Heat H_j. The values $\mu^c_{PCH}(P_q,C_j)$, $\mu^c_{PCH}(P_q,H_j)$, $\mu^{tot}_{PCH}(P_q,C_j)$, $\mu^{tot}_{PCH}(P_q,H_j)$, takes values in [0,1] and $\mu^c_{PCH}(P_q,CH_j)$ takes (0,1) (because it is impossible that the patient has the state Cold and Heat with certain degree 1).
The value $\mu^c_{PCH}(P_q,C_j)=1$ indicates that the Pathogenesis C_j is confirmed. The value $\mu^c_{PCH}(P_q,C_j)=0$ indicates that the pathogenesis C_j is excluded $0<\mu^c_{PCH}(P_q,C_j)<1$ indicates possible pathogenesis C_j.
The value $\mu^c_{PCH}(P_q,H_j)=1$ indicates that the Pathogenesis HC_j is confirmed. The value $\mu^c_{PCH}(P_q,H_j)=0$ indicates that the pathogenesis H_j is excluded $0<\mu^c_{PCH}(P_q,H_j)<1$ indicates possible pathogenesis H_j.

The value $\mu^c_{PCH}(P_q,CH_j)$, takes values in (0,1) indicates possible pathogenesis CH_j.
Let $T=\{T_1, T_2,.., T_n\}$ denotes the set of Meals and Herbal Plants T_k take values $\mu^c_{PT}(P_q,T_k)$ where the values $\mu^c_{PT}(P_q,T_k)$ confirms T_k for patient P_q.
The value $\mu^c_{PT}(P_q,T_k)=1$ indicates that the Treatment T_k is confirmed. The value $\mu^c_{PCH}(P_q,C_j)=0$ indicates that the Treatment T_k is excluded , $0<\mu^c_{PCH}(P_q,C_j)<1$ indicates possible Treatment T_k.
The ralationships betwee entities in Cold- Heat (CH) diagnosis, meals selection and herbal plants untility of Oriental Traditional Medicine may be the following:

$E_i \Rightarrow C_j$ ($\mu^c_{SCH}(E_i,C_j)$),
$E_i \Rightarrow H_j$ ($\mu^c_{SCH}(E_i,H_j)$),
$C_j \Rightarrow T_k$ ($\mu^c_{CHT}(C_j,T_k)$),
$H_j \Rightarrow T_k$ ($\mu^c_{CHT}(H_j,T_k)$),
$CH_j \Rightarrow T_k$ ($\mu^c_{CHT}(CH_j,T_k)$),

Where E_i is a symptom or elementary conjunction of symptoms, C_j is a pathogenesis labelled with Han, H_j is a pathogenesis labeled with Nhiet, CH_j is a pathogenesis labeled with Han- Nhiet, T_k is a Treatment. The values $\mu^c_{SCH}(E_i,C_j)$, $\mu^c_{SCH}(E_i,H_j)$ indicate degrees in which present symptom or elementary conjunction of symptom E_i confirm the pathogenesis C_j and H_j. The values $\mu^c_{CHT}(E_i,T_k)$ indicate degrees in which the pathogenesis C_j and H_j and CH_j confirm Treatment T_k.
The inference rules are used to deduce pathogenesis labeled with Han C_j suffered by patient P_q from the observed symptoms S_i:

$$R^c_{PCH}(E_i,C_j)=R_{PS} \circ R^c_{SCH}(E_i,C_j)$$

defined by:
$$\mu^c_{PCH}(P_q,C_j)=\vee_{Ei\in E} \min\{\mu_{PS}(P_q,E_i), \mu^c_{SCH}(E_i,C_j)\}$$

where $\vee$ stands for a t- conorm. (see [12,13, 14]).
We define a relation of total degree for confirmation of Pathogenesis Cold as following :
$\mu^{tot}_{PCH}(P_q,C_j) = \mu^c_{PCH}(P_q,C_j) \oplus -\mu^c_{PCH}(P_q,H_j)$
if $\mu^c_{PCH}(P_q,C_j) > \mu^c_{PCH}(P_q,H_j)$.

In similar way , we define a relation of total degree for confirmation of Pathogenesis Heat as the following:

$\mu^{tot}_{PCH}(P_q,H_j) = \mu^c_{PCH}(P_q,H_j) \oplus -\mu^c_{PCH}(P_q,C_j)$
if $\mu^c_{PCH}(P_q,H_j) > \mu^c_{PCH}(P_q,C_j)$.

where $\oplus$ is an extended ordered Abelian group operation on [-1,1].
One can see the notion of an extended ordered Abelian group operation on [-1,1] as the combining function of EMYCIN is the following [1]:

$x \oplus_{MC} y = x+y-x.y$ for $x,y \geq 0$,
$x \oplus_{MC} y = x+y+x.y$ for $x,y \leq 0$,
$x \oplus_{MC} y = x+y/(1-\min\{|x|,|y|\})$ for $x.y \leq 0$,

To obtain a conclusion, the following criteria for diagnoses of pathogenesis labeled with Cold, Heat Mixed Cold - Heat and criteria for Treatment are proposed.

Criteria for diagnosis of pathogenesis labeled with Cold:
+ If the value $\mu^{tot}_{PCH}(P_q,C_j)=1$ then absolutely confirmed diagnoses of pathogenesis labeled with Cold C_j for patient P_q are identified.
+ If the value $\mu^{tot}_{PCH}(P_q,C_j)=0$ then absolutely dis-confirmed diagnoses of pathogenesis labeled with Cold C_j for patient P_q are identified.
+ If the value $0<\mu^{tot}_{PCH}(P_q,C_j)<1$ then a "possible" diagnoses of pathogenesis labeled with Cold C_j for patient P_q are identified.

Criteria for diagnosis of pathogenesis labeled with Heat:
+ If the value $\mu^{tot}_{PCH}(P_q,H_j)=1$ then absolutely confirmed diagnoses of pathogenesis labeled with Heat H_j for patient P_q are identified.
+ If the value $\mu^{tot}_{PCH}(P_q,H_j)=0$ then absolutely disconfirmed diagnoses of pathogenesis labeled with Heat H_j for patient P_q are identified.
+ If the value $0<\mu^{tot}_{PCH}(P_q,C_j)<1$ then a "possible" diagnoses of pathogenesis labelled with Heat H_j for patient P_q are identified.

Criteria for diagnosis of pathogenesis labeled with Mixed Cold-Heat:
+ If the value $\mu^{tot}_{PCH}(P_q,C_j)= \mu^{tot}_{PCH}(P_q,H_j)$ in (0,1) then possible diagnosis of pathogenesis labeled with Mixed Cold- Heat CH_j for patient P_q are identified.

Criteria for Treatment of Meals and Herbal Plants T_k:
+ If the value $\mu^c_{CHT}(E_i,T_k)=1$ then absolutely confirmed Treatment T_k for patient P_q are identified.
+ If the value $\mu^c_{CHT}(E_i,T_k)=0$ then absolutely disconfirmed Treatment T_k for patient P_q are identified.
+ If the value $0<\mu^c_{CHT}(E_i,T_k)<1$ then a "possible" Treatment T_k for patient P_q are identified.

Implementation of the COLD-HEAT diagnosis system for selection of suitable meals.
The COLD-HEAT diagnosis system and selection of suitable meals is written in VB 6.0 and consisted of three main modules:
Interface
Cold-Heat diagnosis system for selection of suitable meals uses the graphical interface. It could be able to use by Mouse Click and Keyboard.
As you can see in Figure 1, the Cold-Heat diagnosis system has four command buttons:
- ***Knowledge Acquisition***: View the symptoms list and create new rules.
- ***Cold and Heat Diagnosis***: The system diagnoses when the symptoms are given with the fuzzy degree in [0,1]. After diagnosing, it will give some suitable meals as an advice to help the patient make balance between Yang and Yin.
- ***Help***: Help you to use the system
- ***Exit***: Ending the work.

Figure 1: The interface of the program

Knowledge Acquisition

When you choose Knowledge Acquisition you will see the list of the Cold-Heat symptoms.

-Review the rule base: Rules for the system have general form:

IF <premise> THEN <conclusion> with Degree in [0,1]

<premise> such as set of symptoms about Cold (or Heat)

For example: <fade lip and hand & feet are cold>

<conclusion> that is the Cold (or Heat) which appears on Patient.

<degree> the confirmation of the <conclusion>. It takes value in [0,1].

In the "Edit rule" window (Fig. 2), you can create new rule just by choosing symptom on the list of your left hand. Once the symptom choosed it will be appear on the textbox in the right hand side. In case you select the wrong symptom, you must choose the symptom on the textbox then press deselect symptom. After choosing all the neccessary symptoms to diagnosis the expert give the cold or heat degree into the appropriate box below.

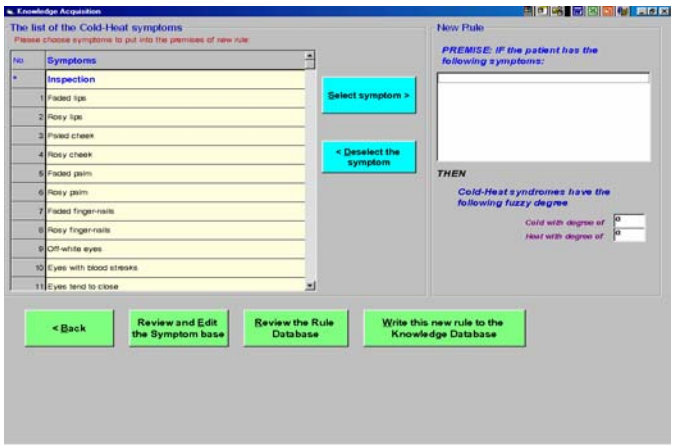

Figure 2: The Editing rule window

- Review and edit symptoms (Figure 3): We all know that the symptoms use to make diagnosis is devided into four main groups: Inspection, Interrogation, Olfaction and Ausculation, and Palpation. Due to this reason, before writing a new symptom you must define which of the four groups the symptom belongs to.

By choosing **Write command** the symptom you create will be add to the symptoms list. From this window, you can remove the symptom that you think it is unnecessaty or they are redundant by choosing the **Remove Symptom** command.

Refresh command help you to refresh the symptom list.

Back is used when you want to return to the previous page.

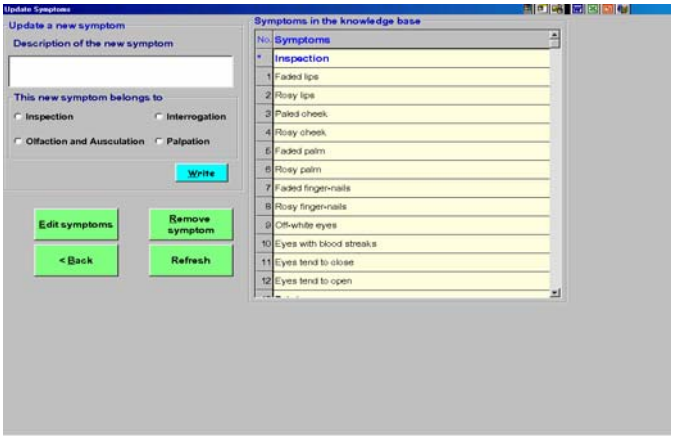

Figure 3: Review and Edit Symptoms window

- The Data rule base Figure 4.

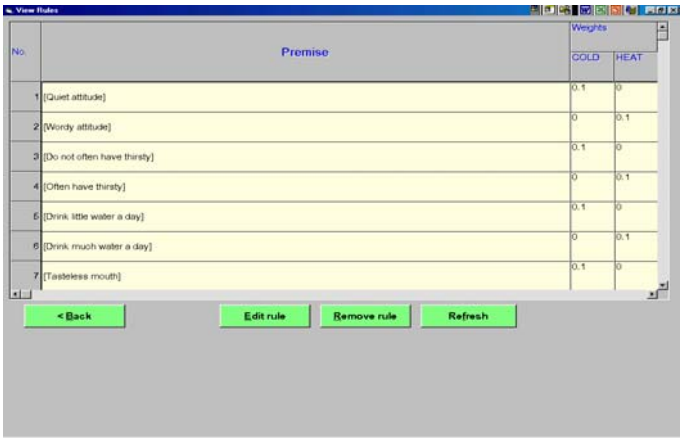

Figure 4: The rule base

Fig. 4 illustrate the rule base. All the rule are store in the knowlegde base. These rule has the Premise and its weight. One rule has only one character: Cold or Heat.

You can remove one rule from this list if this rule is redundant or does not sensible by choosing **Remove rule.**

Back help you to return to the previous page.

One of the key components in the system is the cold-heat diagnosis. In this block, you will see 4 groups of symptoms

on the left hand side. You find the symptom that appear on patient in the left column, decide the degree then press select symptom button. After pressing select symptom, the symptom you choose will place on the right hand side table. You can choose one or more symptom. After selecting all the symptoms just press diagnosis, the system will help you to decide whether the patient is Cold or Heat. (Figure 5)

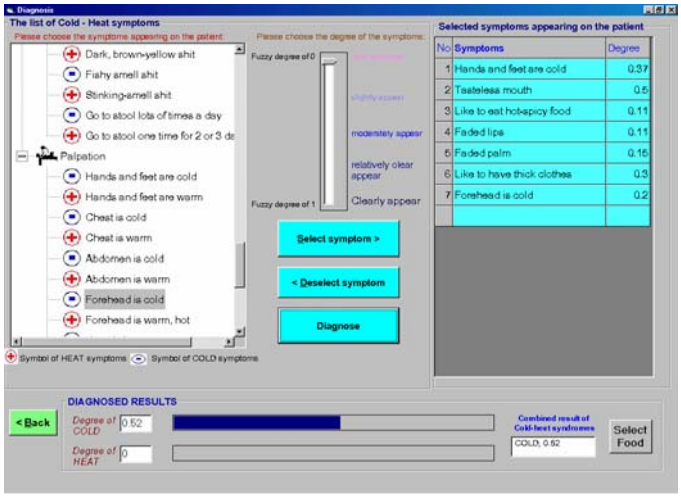

Figure 5: The diagnosis window

Pressing select Food you will see the dishes that could help in defeat the disease

We add picture and information to help you easy to find the meal. Beside it we also provide the character of the meal, you could know why the advise you to try this food by compare the number in the food degree with one in the patient degree.

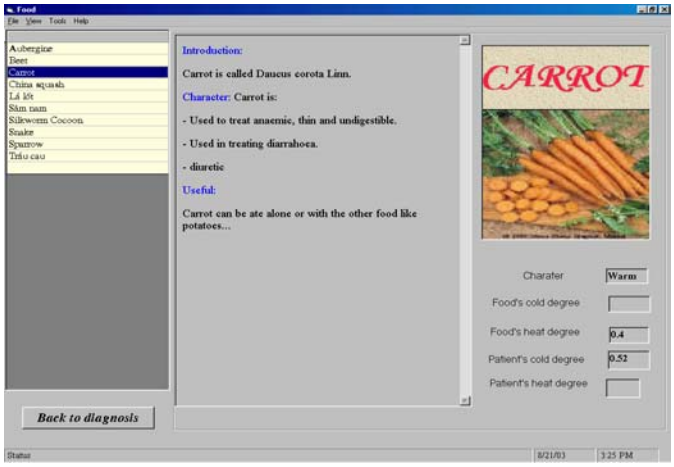

Figure 6: The meals that the system advises

If you want to find more meals, go to the Toolbar/View/All.

Back to diagnosis is used when you want to test another patient.

A patient who is suffered from cold will have the following symptoms:

- Hand and feet are cold
- Tasteless mouth
- Like to eat hot-spicy food
- Faded lips
- Faded palm
- Like to have thick clothes
- Forehead is cold

After choosing these symptoms, press diagnosis you will get the result Cold 0.52. Press Select Food, the program will provide you the meals you should try such as: sparrow, beet, carrot... Each of the meals has its own degree, and the way to cooking. In our example, Carrot has the degree of 0.4 of Heat nature. It helps to make balance with the Cold nature of patient the degree 0.52.

Conclusions

We have described the formalism of the Cold-Heat diagnosis system for selection of suitable measls using fuzzy logic. The implementation and the performance of the system were presented. The system is able to advise suitable meals according to the Cold-Heat state of the patient in order to make balance between Yang and Yin i.e. to prevent diseases.

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