

# A consultation system for Cold - Heat diagnosis according to Vietnamese Traditional medicine combining positive and negative knowledge

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**Abstract** - The aim of the paper is to shown that in practice, the Cold - Heat diagnosis of Vietnamese Traditional Medicine is better to combining positive and negative knowledge. Based on text book and experiences of Traditional medicine practitioner we build the knowledge base combining positive knowledge and negative knowledge for Cold - Heat diagnosis. Then we use the FuzzRESS - A Fuzzy Rule-based Expert System Shell for Medical Consultation combining Positive and Negative Knowledge to such called A consultation system for Cold - Heat diagnosis according to Vietnamese Traditional medicine combining positive and negative knowledge. Finally, the developed system is demonstrated with diagnosis of Cold – Head status according to Vietnamese traditional medicine.

**Keywords** - fuzzy rule based expert system, positive and negative knowledge, medical consultations.

## I. INTRODUCTION

Since 1980's some expert systems using fuzzy sets were developed such as CADIAG-2: Computer – Assisted Medical Diagnosis Using Fuzzy Subsets [10].

In [11] we did analysis the relations between CADIAG-2 and MYCIN-like systems and show that how CADIAG-2 is embedded into MYCIN – like systems.

According to the system of traditional Chinese medicine [18] and Diagnosis and Treatment of the Internal Traditional Medicine [17], Yin and Yang are the two opposing concepts which are used to account for changes in the universe in a comprehensive manner. “In diagnosis, yin and yang symptoms are used to describe the nature of a disease..., a good physician who has mastered the technique of diagnosis will examine the patient's color and take his pulse and he will classify all symptoms into yin and yang as the first step in making a diagnosis”. “In terms of treatment, striking a balance between yin and yang is the most fundamental principle of clinical practice. Among the treatments based on this principle are sedating the excess and toning up the deficiency,...., A hot disease should be treated by cold herbs ... Yin should be treated in yang disease, yang should be treated in yin disease”. Based on the above concepts, human body may have mixed

yin and yang symptoms/symptoms in the same time, therefore, a physician must combine yin and yang symptoms and herbs in order to make diagnosis or treatment. To apply this concept, an approach in this research is to combine positive knowledge (i.e. positive rules stand for confirmation of conclusion) and negative knowledge ( i.e. negative rules stand for exclusion of conclusion) and apply it in consultation of Cold - Heat diagnosis. Cold belongs to the category of Yin and Heat of Yang, therefore the Cold and Heat atates of patient are basic syndromes which play principal role in diagnosis and treatment according to the Vietnamese Traditional medicine.

The contribution of this paper is the following:

- An approach to combining positive knowledge and negative knowledge for Cold - Heat diagnosis is proposed.
- We apply the expert system shell FuzzRESS for building knowledge base for Cold - Head diagnosis.
- We demonstrate the implemented Cold - Head diagnosis system how the system works as an example.
- Some advantages of combining positive knowledge and negative knowledge for Cold - Heat diagnosis are discussed.

The rest of the paper is organized as follows: In the section II, an approach to combining positive knowledge and negative knowledge for cold-heat diagnosis is proposed. In section III, Building knowledge base of the Cold - Heat diagnosis system is described and in the section IV, some examples of demonstration of the Cold - Heat diagnosis system are given. Finally, the conclusions are presented.

## II. COMBINATION OF POSITIVE AND NEGATIVE KNOWLEDGE

In this section, we propose an approach to combining positive and negative knowledge for medical consultations, especially, for Cold-Heat diagnosis of Vietnamese Traditional medicine. Let consider some the following definitions:

*Definition 1:*

A fuzzy patient data for patient  $P_q$  for all  $S_i$  ( $i = 1, \dots, m$ ) is a fuzzy degree  $\mu_{R_{ps}}(P_q, S_i)$ . It takes the value in  $[0, 1]$ .

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- $\mu_{R_{PS}}(P_q, S_i) = 1$  means symptom  $S_i$  surely present for patient  $P_q$ .
- $\mu_{R_{PS}}(P_q, S_i) = 0$  means symptom  $S_i$  surely absent for patient  $P_q$ .
- $0 < \mu_{R_{PS}}(P_q, S_i) < 1$  means symptom  $S_i$  present for patient  $P_q$  with some degree.

*Definition 2:*

Let us have an elementary conjunction  $E_q$  of symptoms  $S_i$  in form of

$$E_q = S_1 \& \dots \& S_m,$$

If for each  $i$ ,  $i = 1, \dots, m$  then we define the value of an elementary conjunction  $E_q$  of symptoms  $S_i$  by

$$\mu_{R_{PS}}(P_q, E_q) = \min_{S_i \in E_q} (\mu_{R_{PS}}(P_q, S_i))$$

In this case, to simplify the practical situation, we assume that conjunction of propositions is not included negated propositions.

*Definition 3:*

A rule base  $\Theta$  (or knowledge base) given by  $\mu_{R_{SD}}^c(E_i, D_j)$  and  $\mu_{R_{SD}}^e(E_i, D_j)$  consists of rules:

$$E_i \rightarrow D_j (\mu_{R_{SD}}^c(E_i, D_j))$$

$$E_i \rightarrow \neg D_j (\mu_{R_{SD}}^e(E_i, D_j))$$

Assume that  $\mu_{R_{SD}}^c(E_i, D_j) = 0$  or  $\mu_{R_{SD}}^e(E_i, D_j) = 0$ ,

where  $\mu_{R_{SD}}^c(E_i, D_j)$ ,  $\mu_{R_{SD}}^e(E_i, D_j)$  are two different fuzzy weights of fuzzy rules in  $[0,1]$ . It is impossible that  $E_i$  both confirms and excludes  $D_j$ . More precisely:

- $\mu_{R_{SD}}^c(E_i, D_j) = 0$  means the elementary conjunction  $E_q$  of symptoms  $S_i$  excludes the conclusion  $D_j$
- $\mu_{R_{SD}}^c(E_i, D_j) = 1$  means the elementary conjunction  $E_q$  of symptoms  $S_i$  confirms the conclusion  $D_j$
- $0 < \mu_{R_{SD}}^c(E_i, D_j) < 1$  means the elementary conjunction  $E_q$  of symptoms  $S_i$  confirms the conclusion  $D_j$  with some fuzzy degree.

It is similar for the case of  $\mu_{R_{SD}}^e(E_i, D_j)$ .

Now we are going to define the total degree of confirmation and exclusion of a diagnosis as a combination of degree of confirmation and degree of exclusion. We shall see that it is more convenient to use their difference in the sense of a group operation on  $(-1,1)$  than just their difference as reals.

*Definition 4:*

Given a patient data, the total degree for confirmation and

exclusion of consultation  $D_j$  by patient  $P_q$  from observed symptoms  $S_i$  is:

$$\mu_{R_{PD}}^{tot}(P_q, D_j) = \mu_{R_{PD}}^c(P_i, D_j) \ominus \mu_{R_{PD}}^e(P_i, D_j) \quad (1)$$

in  $[-1,1]$ ,

where

$$\mu_{R_{PD}}^c(P_i, D_j) =$$

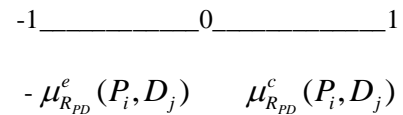
$$\text{Max}_{E_q} \text{Min}[\mu_{R_{PS}}(P_q, E_q); \mu_{R_{SD}}^c(E_q, D_j)],$$

$$\mu_{R_{PD}}^e(P_i, D_j) =$$

$$\text{Max}_{E_q} \text{Min}[\mu_{R_{PS}}(P_q, E_q); \mu_{R_{SD}}^e(E_q, D_j)],$$

(The operation  $\ominus$  will be recalled again in this section), where  $E_q$  varies over all elementary conjunctions of symptoms for which  $\mu_{R_{SD}}^c(E_q, D_j)$  or  $\mu_{R_{SD}}^e(E_q, D_j)$  is positive.

We compare the degree of confirmation  $\mu_{R_{PD}}^c(P_i, D_j)$  and degree of exclusion  $\mu_{R_{PD}}^e(P_i, D_j)$  of diagnosis  $D_j$  for patient  $P_q$ . One can see the representation of these degrees in  $[-1,1]$  in Graph 1.



Graph 1: Representation of  $\mu_{R_{PD}}^c(P_i, D_j)$  and  $\mu_{R_{PD}}^e(P_i, D_j)$

We suppose that  $D_j$  stands for Cold or Heat status according to Vietnamese Traditional Medicine.

Let us recall some notion on  $\oplus$  and  $\ominus$  on  $(-1,1)$ :

- The operation  $\ominus$  is a group operation defined by

$$x \ominus y = x \oplus -y$$

- Operation  $\oplus$  is an ordered Abelian group operation, extended to extremals:

$$1 \oplus x = 1, -1 \oplus x = -1.$$

- The MYCIN group operation  $\oplus$  on  $(-1,1)$  is defined as follows:

$$x \oplus y = x + y + x.y \quad \text{for } x, y \geq 0 \quad (3.1)$$

$$x \oplus y = x + y - x.y \quad \text{for } x, y \leq 0 \quad (3.2)$$

$$x \oplus y = \frac{x + y}{1 - \min(|x|, |y|)} \quad \text{for } x > 0, y < 0, \quad (3.3)$$

Finally, the consultation results are the following:

1. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j) = 1$  means Absolutely Confirmation of Cold or Heat conclusion.

2. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j)$  such that  $0.6 \leq \mu_{R_{PD}}^{tot}(P_q, D_j) < 1$  means Almost Confirmation of Cold or Heat conclusion.
3. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j)$  such that  $\varepsilon \leq \mu_{R_{PD}}^{tot}(P_q, D_j) < 0.6$  means Possible Confirmation of Cold or Heat conclusion.
4. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j)$  such that  $\varepsilon < \mu_{R_{PD}}^{tot}(P_q, D_j) < -\varepsilon$  means “unknown” of Confirmation of Cold or Heat conclusion.
5. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j)$  such that  $-0.6 \leq \mu_{R_{PD}}^{tot}(P_q, D_j) \leq -\varepsilon$  means Possible Exclusion of Cold or Heat conclusion.
6. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j)$  such that  $-1 < \mu_{R_{PD}}^{tot}(P_q, D_j) \leq -0.6$  means Almost Exclusion of Cold or Heat conclusion.
7. The total degree  $\mu_{R_{PD}}^{tot}(P_q, D_j) = -1$  means Absolutely Exclusion of Cold or Heat conclusion.

Where  $\varepsilon$  is a heuristic value and in our case, we take  $\varepsilon = 0.2$ .

### III. BUILDING KNOWLEDGE BASE OF THE COLD - HEAT DIAGNOSIS SYSTEM

We use FuzzRESS: A *Fuzzy Rule-based Expert System Shell* [2] to build knowledge base for a Cold - Heat diagnosis system which consists positive rules and negative rules for Cold or Heat conclusion.

#### Step 1: Knowledge acquisition:

This module allows us to enter symptoms, then we can establish rule base which consists of Positive rules for confirmation of Cold or Heat and negative rules for exclusion of Cold or Heat. We can weighting each rule with their weight in  $[0,1]$ . This module also allows the user to correct the antecedent, succedent and the weight of the rule;

#### Step 2: Building a Knowledge base

Before entering rules into the module Knowledge acquisition, the Knowledge base of rules are empty. After applying Knowledge acquisition module, the system is collected four types of rules as the following:

##### A. Positive rules for Cold diagnosis

1. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent

Urine, loose stools, not-stinking stools, yellow tongue moss, slowly pulse Then Cold (1)

2. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent Urine, loose stools, not-stinking stools, yellow tongue moss Then Cold Then Cold (0.9)

3. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent Urine, loose stools, not-stinking stools Then Cold Then Cold (0.8)

4. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent Urine, loose stools Then Cold Then Cold (0.7)

5. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent Urine Then Cold Then Cold (0.6)

6. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water Then Cold Then Cold (0.5)

7. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink Then Cold Then Cold (0.4)

8. If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour Then Cold Then Cold (0.3)

9. If Cool body, Cold Leg-Hand, Afraid of cold Then Cold Then Cold (0.2)

10. If Cool body, Cold Leg-Hand Then Cold Then Cold (0.1)

11. If Cool body Then Cold (0.05)

##### B. Negative rules for Cold diagnosis

1. If Strong state, active activity, bright sprit, speaking a lot, strong voice, hight fever, red face, red tongue, tongue moss, strong pulse Then Not Cold (0.5).

2. If Strong state, active activity, bright sprit, speaking a lot, strong voice, hight fever, red face, red tongue, tongue moss Then Not Cold (0.45).

3. If Strong state, active activity, bright sprit, speaking a lot, strong voice, hight fever, red face, red tongue Then Not Cold (0.4).

4. If Strong state, active activity, bright sprit, speaking a lot, strong voice, hight fever, red face Then Not Cold (0.35).

5. If Strong state, active activity, bright sprit, speaking a lot, strong voice, hight fever Then Not Cold (0.3).

6. If Strong state, active activity, bright sprit, speaking a lot, strong voice Then Not Cold (0.25).

7. If Strong state, active activity, bright sprit, speaking a lot Then Not Cold (0.2).

8. If Co the khoe, phan ung manh, tinh than lanh loi Then Not Cold (0.15).

9. If Strong state, active activity, bright sprit Then Not Cold (0.1).

10. If Strong state, active activity Then Not Cold (0.05).

##### C. Positive rules for Heat diagnosis

1. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water, Yealow Urine,

loose stools, stinking stools, yellow tongue moss, quickly pule Then Heat (1).

2. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water, Yealow Urine, loose stools, stinking stools, yellow tongue moss Then Heat (0.9).

3. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water, Yealow Urine, loose stools, stinking stools Then Heat (0.8).

4. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water, Yealow Urine, loose stools Then Heat (0.7).

5. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water, Yealow Urine Then Heat (0.6).

6. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink, Like to drink cold water Then Heat (0.5).

7. If heat body, Heat Leg-Hand, tung chan, Red face colour, Not like to drink Then Heat (0.4).

8. If heat body, Heat Leg-Hand, tung chan, Red face colour Then Heat (0.3).

9. If heat body, Heat Leg-Hand, tung chan Then Heat (0.2).

10. If heat body, Heat Leg-Hand Then Heat (0.1).

11. If heat body Then Heat (0.05).

D. Negative rules for Heat diagnosis

1. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing, sweating, pale face, pale tongue, thin tongue, smal pulse Then Not Heat (0.5).

2. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing, sweating, pale face, pale tongue, thin tongue Then Not Heat (0.45).

3. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing, sweating, pale face, pale tongue Then Not Heat (0.4).

4. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing, sweating, pale face Then Not Heat (0.35).

5. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing, sweating Then Not Heat (0.3).

6. If weak status, lazy activity, mournful, speaking a little, weak voice, short breathing Then Not Heat (0.25).

7. If weak status, lazy activity, mournful, speaking a little, weak voice Then Not Heat (0.2).

8. If weak status, lazy activity, mournful, speaking a little Then Not Heat (0.15).

9. If weak status, lazy activity, mournful Then Not Heat (0.1).

10. If Co the suy nhuoc, met moi, luoi hoat dong Then Not Heat (0.05).

11. If weak status, lazy activity Not Heat (0.03).

At present, the system is collected about 50 Positive rules for Cold diagnosis and 20 Negative rules for Cold diagnosis, 50 Positive rules for Heat diagnosis and 20 Negative rules for

Heat diagnosis based on experiences of traditional practitioners and knowledge in the text book [17,18].

Step 3: Using Interface for starting consultation

User can select the symptoms of the patient by choosing symptoms in Head-Neck area, Shouder-Abdominal area, Neural System Area, Hand-leg area..., for example, Cool body, Cold Leg-Hand, Afraid of cold then we assign the weight in [0,1] for every symptom.

Step 4: Inference engine

After colecting symptoms from patient, this module applies the inference process described in Section II on combination of positive and negative knowledge based on symptoms input of the patient, then the system matches the positive and negative rules in the rule base. After combing the positive and negative rules, the result will be the final one as Cold or Heat diagnosis.

Step 5: Explanations

This module applies the forward chaining i.e. the system can explain how the system can reach the conclusion of Cold or Heat. The explanation process starts with the input of symptoms observed at the patient together with symptom's weight. The fired rules for confirmation and exclusion of Cold or Heat are shown. How is combination of rules are calculated.

IV. EXAMPLES OF COLD-HEAT DIAGNOSIS SYSTEM COMBINING POSITIVE AND NEGATIVE KNOWLEDGE

We apply the FuzzRESS system shell to develop the fuzzy system called an expert system for diagnosis of Cold-Heat according to Vietnamese traditional medicine.

The main screen of the fuzzy rule system shell for medical consultation has two main options: 1) Login to Administration and 2) Login to consultation as in Figure 1.

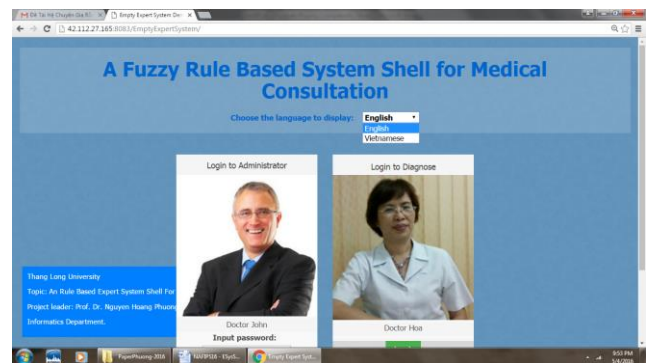
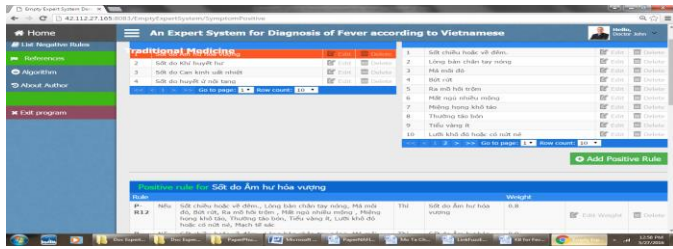


Figure 1: The main screen of the system

The domain expert uses the knowledge acquisition module to enter the positive rules and negative rules for diagnosis of Cold-Heat according to Vietnamese traditional medicine

An example of acquisition for the positive rules is represented

in Figure 2.



**Figure 2:** Example of a positive rule for confirmation of diagnosis

P-R12: If Cool body, Cold Leg-Hand, Afraid of cold, Pale face colour, Like to drink, Like to drink hot water, Transparent Urine, phan long, phan khong thoi Then Cold Then Cold (0.8).

For starting a diagnosis, the system gets the symptoms observed from the examined patient is in the Figure 3.



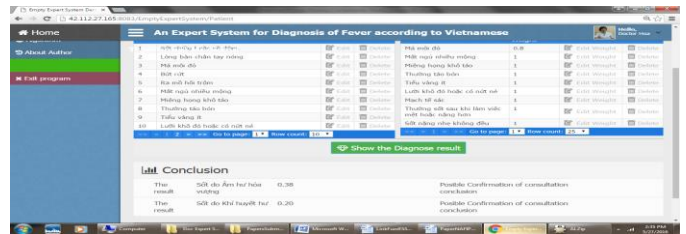
**Figure 3:** Example of symptoms observed from the examined patient

These symptoms are Cool body, Cold Leg-Hand, Afraid of cold...For example, the symptom Cold Leg-Hand gets the weight 0.8 which means the Leg-Hand represents the membership of Cold at the patient with the degree 0.8.

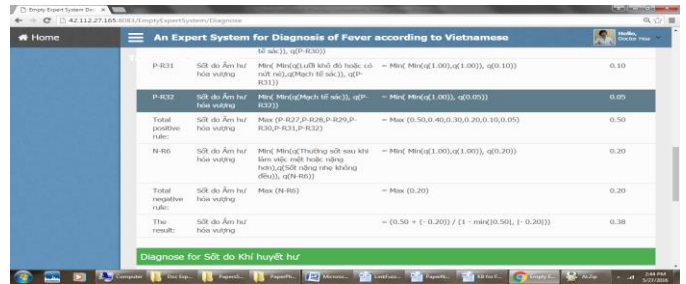
After matching all the patient input with positive and negative rules for confirmation and exclusion of Cold, the diagnosis of diseases will be ranked from height values to the low values in [-1,1] the Figure 4.

The results of diagnosis of Cold is with the confirmation degree 0.38

The module Explanation provides the processes how to calculate the values of diagnosis for diseases using forward chaining technique of inference. In Figure 5 shows the explanation of combination of the results of positive and negative rules for confirmation and exclusion of Cold status.



**Figure 4:** Diagnosis for Cold according to Vietnamese traditional medicine.



**Figure 5:** Explanation of calculation and combining results of positive and negative rules.

In Figure 5, the calculation of every rules is presented and the total positive rule degree is 0.5 and the total negative rule degree is 0.2. Then the degree of combining positive and negative rules is 0.38.

## V. CONCLUSIONS

In this paper, a consultation system for Cold - Heat diagnosis according to Vietnamese Traditional medicine combining positive and negative knowledge. The approach how to combining positive and negative knowledge for medical consultations was proposed. Based on the FuzzRESS system shell, knowledge base of the Cold - Heat diagnosis system was collected. Finally, the developed Cold - Heat diagnosis system is running in the computer to expressing how the system works. The advantages of combining positive knowledge and negative knowledge for Cold - Heat diagnosis give a possibility to get more accuracy result because the system, in the same time, can manage the symptoms for confirmation or exclusion of Cold (or Heat) from the observed patient.

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