## 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  $\mu_i$  in [0,1]. Values  $\mu_i$  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  $\mu_{si}$  in (0,1) means possible

hypothesis of presence of symptom  $S_i$  for patient  $P_q$  and value  $\mu_{si}=\epsilon$  means that symptom  $S_i$  is undefined ( $\epsilon$  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<sub>1</sub>, C<sub>2</sub>,..., C<sub>n</sub>,H<sub>1</sub>, H<sub>2</sub>,...,H<sub>n</sub>,CH<sub>1</sub>, CH<sub>2</sub>,...,CH<sub>n</sub>} 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<sub>q</sub>,C<sub>j</sub>),  $\mu^{c}_{PCH}$  (P<sub>q</sub>,H<sub>j</sub>),  $\mu^{c}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>),  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>),  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>),  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>),  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>),  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>), where the values  $\mu^{c}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>) confirms Cold state,  $\mu^{c}_{PCH}$  (P<sub>q</sub>,H<sub>j</sub>) confirms Heat state, and  $\mu^{c}_{PCH}$  (P<sub>q</sub>,CH<sub>j</sub>) confirms Mix Cold- Heat state by patient P<sub>q</sub> 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<sub>q</sub>,CH<sub>j</sub>), takes values in (0,1) indicates possible pathogenesis CH<sub>j</sub>.

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:

$$\begin{split} & E_i \Rightarrow C_j \left( \mu^c_{SCH} \left( E_i, C_j \right) \right), \\ & E_i \Rightarrow H_j \left( \mu^c_{SCH} \left( E_i, H_j \right) \right), \\ & C_j \Rightarrow T_k \left( \mu^c_{CHT} \left( C_j, T_k \right) \right), \\ & H_j \Rightarrow T_k \left( \mu^c_{CHT} \left( H_j, T_k \right) \right), \\ & CH_j \Rightarrow T_k \left( \mu^c_{CHT} \left( CH_j, T_k \right) \right), \end{split}$$

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  $S_i$ :

 $R^{c}_{PCH}(E_i,C_j)=R_{PS}OR^{c}_{SCH}(E_i,C_j)$ 

defined by:

 $\mu^{c}_{PCH}$  ( $P_{q}$ , $C_{i}$ )= $\vee_{Ei \in E} min\{\mu_{PS} (P_{q},E_{i}), \mu^{c}_{SCH} (E_{i},C_{i})\}$ 

where  $\lor$  stands for a t- conorm. (see [12,13, 14]). We define a relation of total degree for confirmation of Pathogenesis Cold as following :

$$\begin{split} & \mu^{\text{tot}}_{\text{ PCH }}\left(P_{q},C_{j}\right) = \mu^{c}_{\text{ PCH }}\left(P_{q},C_{j}\right) \oplus -\mu^{c}_{\text{ PCH }}\left(P_{q},H_{j}\right) \\ & \text{if } \mu^{c}_{\text{ PCH }}\left(P_{q},C_{j}\right) \!\!>\!\!\mu^{c}_{\text{ PCH }}\left(P_{q},H_{j}\right). \end{split}$$

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

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]:

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\begin{array}{ll} x \oplus_{MC} y=x+y-x.y & \mbox{for } x,y \geq 0, \\ x \oplus_{MC} y=x+y+x.y & \mbox{for } x,y \leq 0, \\ x \oplus_{MC} y=x+y/(1-min\{|x|,|y|\} & \mbox{for } x.y \leq 0, \end{array}
```

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<sub>q</sub>,C<sub>j</sub>)=1 then absolutely confirmed diagnoses of pathogenesis labeled with Cold C<sub>j</sub> for patient P<sub>q</sub> are identified.

+ If the value  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,C<sub>j</sub>)=0 then absolutely disconfirmed diagnoses of pathogenesis labeled with Cold C<sub>j</sub> for patient P<sub>q</sub> are identified.

+ If the value  $0 \le \mu^{tot}_{PCH}$  ( $P_q, C_j$ ) $\le 1$  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<sub>q</sub>,H<sub>j</sub>)=1 then absolutely confirmed diagnoses of pathogenesis labeled with Heat H<sub>j</sub> for patient P<sub>q</sub> are identified.

+ If the value  $\mu^{tot}_{PCH}$  (P<sub>q</sub>,H<sub>j</sub>)=0 then absolutely disconfirmed diagnoses of pathogenesis labeled with Heat H<sub>j</sub> for patient P<sub>q</sub> are identified.

+ If the value  $0 \le \mu^{tot}_{PCH}$  ( $P_q, C_j$ ) $\le 1$  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<sub>j</sub> for patient P<sub>q</sub> are identified.

### Criteria for Treatment of Meals and Herbal Plants T<sub>k</sub>:

+ If the value  $\mu^{c}_{CHT}$  (E<sub>i</sub>,T<sub>k</sub>)=1 then absolutely confirmed Treatment T<sub>k</sub> for patient P<sub>q</sub> are identified.

+ If the value  $\mu^{c}_{CHT}$  (E<sub>i</sub>,T<sub>k</sub>)=0 then absolutely disconfirmed Treatment T<sub>k</sub> for patient P<sub>q</sub> are identified.

+ If the value  $0 \le \mu^c_{CHT}$  (E<sub>i</sub>,T<sub>k</sub>) $\le 1$  then a "possible" Treatment T<sub>k</sub> for patient P<sub>q</sub> 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]

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.

Symptoms     PREMISE: If the pactor has not	1.100010-0	t of the Cold-H	to put into the premises of new r	ule:		New Pule	
Inspection   Inspection   Packet ligs   2 Cory tan   3 Packet create   4 Daty create   6 Daty prime   6 Daty pain   6 Daty prime   7 Packet fright   7 Packet fright   0 Daty prime rails   0 Doty fright rails	NO .	Symptoms		-			thas the
2 Rarry type   3 Paste Cheek   4 Rarry type   4 Rarry cheek   6 Paste Cheek   6 Paste Cheek   6 Paste Cheek   6 Paste Cheek   7 Paste fright-rasin   7 Paste fright-rasin   9 Off-India syndromes his following fruzz degree Jeast with degree   90 Off-India syndromes his following traze degree Jeast with degree   10 Cyste with Bood streaks		Inspection			1		
2 Praduct steek   4 Rody orbited   5 Packed gaim   6 Rody gaim   7 Packed fright toget name   8 Rody toget name   9 Rody toget name   90 Rody toget name	1	Foxled lips		Sele	ct symptom >		
Rosy cheak R	2	Rosy lips					
Non-control control     Symptom       6     Flasts fright-rains     Cold-Meant Syndhomes In following fuzz y degrees       7     Flasts fright-rains     Cold-Meant Syndhomes In following fuzz y degrees       8     Roty tright-rains     Cold-Meant Syndhomes In following fuzz y degrees       9     Oct-white eyes     Cold-Meant Syndhomes In following fuzz y degrees       90     Synthese eyes     Cold web eige       90     Synthese eyes     Assi with eige	3	Poled cheek					
5 Factor gam THEN   6 Reary gam Cold-Heat syndromes he following factor; depression   7 Factor from-raine Broary forger-raine   8 Reary forger-raine Cold-Heat syndromes he following factor; depression   9 Obtients eyee Cold with depression   10 Eyes with blood streams Factor; depression	4	Rosy cheek					
Y Faded freger-name Yeaded freger-name Generatin Regiver Toger-name Generatin Generatin Generatin Generatin Generatin Generatin Generatin Generatin Generatin	5	Foded paim		Contraction of the second		THEN	
7 Padat fregrinals 8 Rev Fregrinals Colification Colifi	6	Rosy paim					
B Recy Toger rolls Asser with any Off-India wys Off-India wys Off-India wys	7	Foxled finger-naite	í.				The second
10 Eyes with blood atreaks	8	Rosy finger-nails					
	9	Off-white eyes					
11 Eyes tend to close	10	Eyes with blood a	treske.				
	11	Eyes tend to close	e	1			
Keview and Edit the Symptom base Review the Rule Database Write this new rule to the Knowledge Database		< Back					

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.

Indate a new symptom		Sy	mptoms in the knowledge base	
Description of the new sy	motom	No	Symptoms	4
		•	Inspection	
			Faded lips	
This new symptom belon	gs to	2	Rosy lips	1
Inspection	C Interrogation	3	Paled check	
Olfaction and Ausculatio	n C Palpation	3	Rosy check	
Onaction and Adsociatio	n · Palpation	t	Faded paim	
	Write	e	Rosy palm	
		7	Faded finger-nails	
	The second second	E	Rosy finger-nails	
Edit symptoms	Remove	1	Off-white eyes	
		10	Eyes with blood streaks	
< <u>B</u> ack	Refresh	11	Eyes tend to close	
a de la compañía de		12	Eyes tend to open	
		1.1.1.		1

Figure 3: Review and Edit Symptoms window

- The Data rule base Figure 4.

	Weights	
Premise	COLD	HEAT
(Quiet attitude)	0.1	0
(Wordy attribute)	0	0,1
[Do not often have thirsty]	0.1	0
[Often have thirsty]	0	0.1
[Drink little water a day]	0.1	0
[Drink much water a day]	0	0.1
[Tastetess mouth]	0.1	0
	Quiet attlusk) Wordy attlusk) Do not often have thirsky Often have thirsky Drivk Ittle water a day Drivk ruch water a day	Quest attitude)     Quest atti

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)

list of Cold - Heat symptoms mee choose the symptome speeding on the patient.	The start of a	eome of the symptoms:	Sel	ected symptoms appearing or	the patient
Oark, brown-yellow shit	Fuzzy degree of 0	egitte or the symptomic.	No	Symptoms	Degree
Fishy smell shit	Filly begins bro		1	Hands and feet are cold	0.3
Stinking-amell shit		shipiny account	2	Taatelesa mouth	0.6
Go to stool lots of times a day		The second second	3	Like to eat hot-spicy food	0.1
Go to stool one time for 2 or 3 d		moderately appear	4	Faded lips	0.1
Palpation			5	Faded palm	0.1
- ( Hands and feet are cold		relatively olean appear	6	Like to have thick clothes	0.0
Hands and feet are warm	Fuzzy degree of 1	Clearly appear	7	Forehead is cold	0.
Chest is cold	Fuzzy degree of 1	_ costiny approxim			
- Cheat is warm	Select s	ymptom >			
Abdomen is cold					
- 🕀 Abdomen is warm	< Deseleo	tsymptom			
Forehead is cold					
- 📀 Forehead is warm, hot	Diag	nose			

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.

CARRO
winne
State of the second
Server al
d like
l like
like
like
a sub-
like Charater Warm
Charater Warn
a sub-
Charater Warn Food's cold degree
Charater Warn
Charater Ware Food's cold degree Food's heat degree p.4
Charater Warn Food's cold degree
Charafer Warn Food's cold degree Food's heat degree P4 Potent's cold degree 9.53
Charafer Warn Food's cold degree 94 Food's heat degree 94 Patient's cold degree 952 Patient's heat degree
Charafer Warn Food's cold degree Food's heat degree P4 Potent's cold degree 9.53

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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