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SYNDROME DIFFERENTIATION OF SIX MERIDIANS FOR WARM DISEASE BASED ON STRUCTURAL PARTIAL-ORDERED ATTRIBUTE DIAGRAM

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Abstract. Data mining for Traditional Chinese Medicine has been a significant and challenging issue in the process of the modernization of Traditional Chinese Medicine. This paper presents a method of discovering rules for Traditional Chinese Medicine based on the theory of structural partial-ordered attribute diagram. The source data of this paper’s formal context are from Sishengxuanshu, written by Yuanyu Huang, a famous Chinese doctor of the Qing Dynasty. Based on the eight prescriptions used by Mr. Huang for warm disease, the formal context has been established, and thus some structural partial-ordered attribute diagrams are generated. Finally, combining the structural partial-ordered attribute diagrams and syndrome differentiation of six channels theory, some useful rules have been discovered.

Keywords: Structural partial-ordered attribute diagram, Data mining for Traditional Chinese Medicine, Warm disease, Syndrome differentiation of six meridians theory

1. Introduction. Aimed at standardizing Traditional Chinese Medicine (TCM), the modernization of TCM has been a hot field of the scientific community in modern society. To promote this process, finding the differences between Chinese and Western medical theories is the first key [1]. As was commonly believed, Western medicine is experimental science based on analysis, while TCM is based on the perception of people [2]. The second key to the modernization of TCM is to select a method for data mining, and the theory of the method should be consistent with TCM’s.

Compared with common data mining, data mining of TCM is more complex both in the complexity of data and the algorithm of the mode [3]. Currently, the most common methods for data mining of TCM are cluster analysis [4], association rules [5], principal component analysis (PCA) [6] and neural network analysis [7]. Analyzing these methods, we can easily find that PCA concentrates on the function of one part of a whole system, but ignore the interactions between the parts. This is contrary to the theory of TCM, so its prospect in TCM is not so good; the theories of cluster analysis, association rules and neural network are all consistent with TCM’s in some extent, but their conclusions are presented in an abstract way, and their results are not visualized.

Structural partial-ordered attribute diagram is a new method used for data analysis and extracting rules from the form context. It emphasizes cognitive ability and concentrates on the relation between different things. Its theory is consistent with the theory of TCM, and its results are presented in the form of diagrams, which is visualized. So in this study, we use the structural partial-ordered attribute diagram to analyze the eight prescriptions for warm disease. The process of this article is divided into four major components: data input, formal context, structural partial-ordered attribute diagram, data analysis.
2. Theory of Structural Partial-Ordered Attribute Diagram. A formal context 
\[ K = (U, M, I) \] consists of two sets \( U = \{u_1, u_2, \ldots, u_n\} \) and \( M = \{m_1, m_2, \ldots, m_k\} \) and a relation \( I \) between \( U \) and \( M \). The elements of \( U \) are called the objects and the elements of \( M \) are called the attributes of the context. Suppose \( m \in M \), we define 
\[ f(m) = \{u \in U | (u, m) \in I\} \]
which denotes the object set of attribute \( m \); meanwhile, suppose \( u \in U \), we define 
\[ g(u) = \{m \in M | (u, m) \in I\} \]
which denotes the attributes set of object \( u \).

Next, we briefly introduce some basic definitions and mathematic descriptions about attributes used in this article.

**Definition 2.1.** Suppose there is a formal context \( K = (U, M, I) \), if the attribute \( m \in M \) satisfies the condition:
\[ \{g(m)|m \in M\} = U \] (1)
we call \( m \) the maximum common attribute of the all attributes.

**Definition 2.2.** Suppose there is a formal context \( K = (U, M, I) \), if the attribute \( m \in M \) satisfies the conditions:
\[ \{g(m)|m \in M\} \neq U \] (2)
\[ m_i \in M - m, g(m) \not\subset g(m_i), \ (i = 1, 2, 3, \ldots, n) \] (3)
\[ m_i, m_j \in M, g(m_i) \cup g(m_j) \subset g(m), \ (i, j = 1, 2, 3, \ldots, n) \] (4)
we call \( m \) the common attribute.

**Definition 2.3.** Suppose there is a formal context \( K = (U, M, I) \), if the attributes \( m_i, m_j \in M \) and satisfy the conditions:
\[ g(m_i) \cup g(m_j) = U \] (5)
\[ g(m_i) \cap g(m_j) = \Phi \] (6)
we call \( m_i, m_j \) the opposite attribute with each other.

**Definition 2.4.** Suppose there is a formal context \( K = (U, M, I) \), if the attributes \( m_i, m_j \in M \) and satisfy the conditions:
\[ g(m_i) \neq g(m_j) \] (7)
\[ g(m_i) \cap g(m_j) \neq \Phi \] (8)
We call \( m_i, m_j \) the attributes that do not include each other.

**Definition 2.5.** Suppose there is a formal context \( K = (U, M, I) \), if there is an attribute \( m \in M \), and it satisfies the condition:
\[ |g(m)| = 1, \ (|g(m)| \text{ means the number of the objects with the attribute } m) \]
we call \( m \) the unique attribute.

Based on these definitions and descriptions we construct the structural partial-ordered attribute diagram [9].

3. Data Analysis.

3.1. Analysis of SPOAD (structural partial-ordered attribute diagram). Figure 1 shows the structural partial-ordered attribute diagram of the eight prescriptions for warm disease used by Mr. Huang [10]. In the formal context of Figure 1, the eight prescriptions are regarded as objects and the medicines contained in the prescriptions are attributes. Based on this formal context and the former theory [9], Figure 1 is generated.

**Objects:** o1: Suxue Dan o2: Xuanshuang Dan o3: Canglin Dan o4: Huangsudan o5: Hongyu Dan o6: Ziyu Dan o7: Renshenbaihu Soup o8: Baiying Dan

Among the eight objects, o1 is used for Yangming Meridian Syndrome of warm disease; o2 is used for Taiyang Meridian Syndrome of warm disease; o3 is used for Jueyin Meridian Syndrome of warm disease; o4 is used for Taiyin Meridian Syndrome of warm disease; o5 is used for Shaoyang Meridian Syndrome of warm disease; o6 is used for Shaoyin Meridian Syndrome of warm disease; o7 is used for Yangming Meridian Syndrome of warm disease, which is overheated; o8 is used when the pathogenic factor is transferred from Meridians to the viscera.

From the top layer of the structural partial-ordered attribute diagram, we can see that Mr. Huang used $\{a3\} = \{\text{Licorice}\}$ in all the 8 prescriptions for warm disease. According to the theory of TCM, the reason is that: on one hand, Licorice has the function to harmonize all kinds of medicines, and it can make other medicines in the same prescription work harmoniously; on the other hand, Licorice’s target meridians are Taiyin Spleen Meridian of Foot and Yangming Stomach Meridian of Foot and its mild property can protect the Spleen and Stomach from the harm of the other medicines.

In the second layer, the diagram is divided into two clusters: $\{a5\} = \{\text{Tree Peony Root Bark}\}$ and $\{a7\} = \{\text{Ginger}\}$. In the cluster of Ginger, there are 7 prescriptions, and they are all used when the pathogenic factor is in the meridians. Ginger can dredge the meridians, so when the pathogenic factor is in the meridians, Ginger is used; when the pathogenic factor has transferred from meridians to the viscera, Ginger is removed. This presents the accuracy of Chinese medicine use.

Now we look at the prescriptions for Meridians Syndrome. As was shown in Figure 1, the prescriptions can be divided into two clusters: $\{a5\} = \{\text{Tree Peony Root Bark}\}$ and $\{a13\} = \{\text{Rhizoma Anemarrhenae}\}$. 
In the cluster of Tree Peony Root Bark, we can see that Mr. Huang selected \( \{a5\} = \{\text{Tree Peony Root Bark}\} \) and \( \{a6\} = \{\text{Peony}\} \) for the treatment of the Yangming, Taiyang, Jueyin, Taiyin and Shaoyang Meridian Syndrome of warm disease. As previously mentioned, warm disease evolves from the loss of kidney’s function and the adversity of Gallbladder Meridian, and Liver Meridian is interlinked closely with Gallbladder Meridian, so the adversity of Gallbladder Meridian leads to the adversity of Liver Meridian necessarily. Tree Peony Root Bark’s target meridian is Liver Meridian, and it can reverse the adversity liver; Peony’s target meridians are Liver and Gallbladder Meridians, and it can reverse the adversity of gallbladder.

In the cluster of \( \{a13\} = \{\text{Rhizoma Anemarrhenae}\} \), we can see that Mr. Huang selected Rhizoma Anemarrhenae for the treatment of Shaoyin Meridian Syndrome and Yangming Meridian Syndrome which is overheated. Rhizoma Anemarrhenae’s target meridians are Lung Meridian and Bladder Meridian. It can cool the lung, so it is used for Yangming Meridian Syndrome when the overheat burns the lung; it can also clear the heat of Bladder Meridian, and Shaoyin Kidney Meridian is interlinked closely with Bladder Meridian, so it can treat Shaoyin Meridian Syndrome as well.

From \( \{o8\} = \{\text{Baiying Dan}\} \) we can see that, Mr. Huang used \( \{a5\} = \{\text{Tree Peony Bark}\}, \{a6\} = \{\text{Peony}\}, \{a4\} = \{\text{Figwort Root}\}, \{a20\} = \{\text{Unprocessed Rehmannia Root}\}, \{a2\} = \{\text{Dwarf Lilyturf Tuber}\}, \{a16\} = \{\text{Rhubarb}\}, \{a17\} = \{\text{Mirabilite}\}, \{a18\} = \{\text{Immature Orange Fruit}\}, \{a19\} = \{\text{Officinal Magnolia Bark}\} \) these medicines when the pathogenic factor has transferred from meridians to the viscera.

The Traditional Chinese Medicine believes that warm disease originates in the loss of kidney’s ability to control the fire of Sanjiao. When the fire of Sanjiao is out of control, it leads to the adversity of Gallbladder Meridian; thus, the gallbladder qi is transformed into fire, and this causes the interior heat of the body. At first, the interior heat is hidden in the body, but once it is stimulated by the exterior pathogenic factor, it will burn lung, stomach and spleen. When spleen is harmed, it will cause the adversity of liver. So Mr. Huang used Tree Peony Root Bark and Peony to reverse the adversity of liver and gallbladder, selected Unprocessed Rehmannia Root for clearing the heat of spleen and chose Dwarf Lilyturf Tuber to clear the heat of lung and stomach. Figwort Root is used to make lung qi down so that the kidney’s ability to control the fire of Saojiao is strengthened. At last, Immature Orange Fruit and Officinal Magnolia Bark are selected for reversing the adversity of stomach.

3.2. Analysis of SPOOD (structural partial-ordered object diagram). Figure 2 is the structural partial-ordered object diagram of the eight prescriptions for warm disease used by Mr. Huang. In the formal context of Figure 2, the eight prescriptions are regarded as the attributes, and the medicines they contain are objects. Based on this formal context and the former theory [9], Figure 2 is generated. From Figure 2, we can easily find the unique medicines of each prescription.


**Attributes:** a1: Xuanshuang Dan a2: Suxue Dan a3: Renshenbaihu Soup a4: Hongyu Dan a5: Baiying Dan a6: Huangsu Dan a7: Ziyu Dan a8: Canglin Dan

Suxue Dan is used when the pathogenic factor is in the Yangming Meridians, its unique medicine is Kudzuvine Root, and the target meridian of Kudzuvine Root is Yangming Stomach Meridian of Foot; Canglin Dan is used when the pathogenic factor is in the Jueyin Meridians, its unique medicine is Chinese Angelica, and the target meridian of Chinese
Angelica is Jueyin Liver Meridian of Foot; Hongyu Dan is used when the pathogenic factor is in the Shaoyang Meridians, its unique medicines are Bupleurum and Baical Skullcap Root, and one of the target meridians of Baical Skullcap Root is Shaoyang Gallbladder Meridian of Foot; Renshenbaihu Soup is used when the pathogenic factor is in the Yangming Meridians, its unique medicines are Ginseng and Japonica Rice, and Yangming Stomach Meridian of Foot is the target meridian of both this medicines.

Through these analysis, we can infer that the consistence between the syndrome of Meridians and the target meridians of the unique medicines of each prescription has supported the exactness of the Chinese medicines’ target theory in some extent.

4. Conclusions. In this study, we can find that structural partial-ordered attribute diagram works well in extracting rules in the prescriptions for warm disease. With the help of the structural partial-ordered attribute diagram, we can easily find the similarities and differences between the prescriptions. So structural partial-ordered attribute diagram should be a good tool for data mining in TCM; taking advantage of it, we can make further research in the fields of TCM, such as the links between the syndrome and disease, the rules of making prescriptions. So it should be used widely to promote the modernization of Traditional Chinese Medicine.

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