Two Dimensions Data Slicing Algorithm, a New Approach in Mining Rules of Literature in Traditional Chinese Medicine

Guang Zheng[1,2], Hongtao Guo[2,3], Yuming Guo[2,3], Xiaojuan He[2], Zhongxian Li[1], and Aiping Lu[2,⋆]

[1] School of Information Science-Engineering, Lanzhou University, Lanzhou, 730000, China
[2] Institute of Basic Research in Clinical Medicine, China Academy of Chinese Medical Sciences, Dongzhimen, Beijing, 100700, China
[3] Shanghai University of Traditional Chinese Medicine, Shanghai, 201203, China
lap64067611@126.com

Abstract. Chinese medicinal herbs, acupuncture, and patterns are important components in traditional Chinese medicine. In this paper, focused on facial nerve paralysis, we proposed an algorithm named two dimensions data slicing to mine rules of Chinese medicinal herbs, acupuncture, and patterns. The process of mining was done in two dimensions. The one-dimension analyzes the frequencies of Chinese medicinal herbs, acupoints, and patterns. The two-dimension analyzes the frequencies of co-existed keyword pairs. By examining the results of these two dimensions, although some noises existed, most regular knowledge of treating this disease is mined out. This algorithm might be useful in mining rules in the literature of traditional Chinese medicine.

Keywords: Data mining, facial nerve paralysis, two dimension data slicing algorithm, traditional Chinese medicine

1 Introduction

Acupuncture [22, 25, 26], Chinese medicinal herbs [21], and diagnoses [23] are important component procedures in traditional Chinese medicine which prevent and treat diseases. Since they are effective, simple in clinical practice, and low in cost, they have been widely used in China and countries around China for thousands of years.

The application of acupuncture and moxibustion through stimulating certain acupoints on the human body is to activate the meridians and collaterals so as to regulate the functions of the internal organs, qi, and blood so as to prevent and treat diseases [22].

Nowadays, there are many debates in the field of acupuncture [15, 16, 27]. However, in the clinical practice of traditional Chinese medicine, acupuncture is widely used in the treatment of facial nerve paralysis [24, 5, 11, 8, 9, 13, 14].

⋆ Corresponding author.

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Chinese medicinal herbs is one of the most important modalities utilized in traditional Chinese medicine (TCM). Each herbal medicine prescription is a cocktail of many herbs tailored to the individual patient. One batch of herbs is typically decocted twice over the course of one hour. The practitioner usually designs a remedy using one or two main ingredients that target the illness. Then the practitioner adds many other ingredients to adjust the formula to the patient's patterns. Sometimes, ingredients are needed as it is believed that it will cancel out toxicity or side-effects of the main ingredients. Some herbs require the use of other ingredients as catalyst or else the brew is considered to be ineffective. The latter steps require great experience and knowledge, and make the difference between what is accepted as a good Chinese herbal doctor and an amateur. Unlike western medications, the balance and interaction of all the ingredients are considered more important than the effect of individual ingredients. A key to success in TCM is the treatment of each patient as an individual [18].

For diagnoses in traditional Chinese medicine, there are four diagnostic methods to observe and diagnose disease. These methods are inspection, auscultation, inquiry, and pulse-taking and palpation, refer to the four basic procedures used in diagnosing a disease. They are the presuppositions of correct differentiation and effective treatment in traditional Chinese medicine [23].

In traditional Chinese medicine, acupuncturists believe that hand and foot yang meridians are all pass on to the top of face. If face meridians are blocked by external pathogen, especially meridian sinew of Small Intestine and Stomach Meridian dysfunction can lead to the occurrence of facial nerve paralysis [26,22].

In this paper, by examining data/text mining algorithms existed nowadays [7, 1, 2, 3, 6, 10, 12, 20], we created a two dimension data slicing algorithm. By executing it, we calculated the acupoint sets in the treatment of facial nerve paralysis in two dimensions. One-dimension is to calculate the frequency of single acupoints, Chinese medicinal herbs, and patterns existed in the literature. Two-dimension is to calculate the frequencies of co-existed pairs of them. Then, slice them according to their frequencies and then, compare them with the textbook of acupuncturology for further analysis.

As there maybe confusion in the translation of acupoints and other terminologies in traditional Chinese medicine, we refer to WHO standards [17, 19].

2 Material and Methods

2.1 Material: Data Preparation

In SinoMed (http://sinomed.imicams.ac.cn/index.jsp), on the default query strategy, we queried on the keyword of "facial nerve paralysis" in Chinese. As a result, we fetched a data set of 8,261 records on Dec. 29, 2010. These data set are focused on the treatments and reviews on facial nerve paralysis. Take acupints for example, we want to get different levels of acupoints in the treatment of facial nerve paralysis by text mining. Chinese medicinal herbs and patterns can be treated in the same way.

When the data set is ready, we get it formatted from un-structured text file into structured database. By doing this, we get a record set of 459 records formatted from 8,261 papers. They are filtered out from keywords and abstracts by the lists of acupoints. They contain the paper ID and the associated acupoints, line by line. In order to simplify the description of algorithm, these data are assumed to be stored in "TABLE_I" with fields of "PMID (paper ID)" and "keyword (name of acupoint)". In this paper, we focus on the distribution of acupoints in treating facial nerve paralysis.

When TABLE_I is constructed, we will analysis these acupoints in two different dimensions. In one-dimension, these acupoints will be calculated for their frequencies in literature. That is to say, the frequencies of the acupoints' occurrence will be calculated and listed in the descendent order. In two-dimension, the binary relationships of these acupoints will be calculated. What's more, the co-occurrent frequencies are also calculated and assigned to the binary relationships. That is to say, the frequencies of co-occurrent acupoint-pairs will be calculated and listed in descendent order.

2.2 Method: One-Dimension Data Slicing Algorithm

One-dimension analyzes the frequencies of the acupoints existed in literature focused on "facial nerve paralysis". Based on the data in "TABLE_I", "keyword" will be calculated for their frequencies. The "keyword", together with its frequency, will be stored in "TABLE_II" with fields of "keyword" and "ps (for frequency)".

To be more specifically, we list the algorithm of one dimension in Table I.

Thus, in "TABLE_II", the frequencies of acupoints can be calculated in field "keyword" in the descendent order.

Table 1. Algorithm of One Dimension

```
USE TABLE_I
DO WHILE NOT EMPTY
GO TOP
  kw = keyword
  frqcy =frequency(kw)    //calculate the frequency of kw in the whole list
  USE TABLE_II
    APPEND BLANK
    REPLACE keyword WITH kw, ps WITH frqcy
  USE TABLE_I
  DELETE ALL keyword = kw
ENDDO
USE TABLE_II
SORT ON ps DESCENDENT    //keywords sorted on descending order of ps
```

2.3 Method: Two-Dimension Data Slicing Algorithm

Based on the principle of algorithm described in [7]. Two-dimension analyzes the frequencies of co-occurrent acupoint-pairs existed in literature focused on "facial nerve paralysis". Based on the data in "TABLE_I", acupoints in field "keyword" will be calculated according to each "PMID". That is, according to one "PMID", every two different acupoints associated with it form a binary relationship (co-occurrent acupoint-pair). They are stored in "TABLE_III" with fields of "lh" (left hand of co-occurrent acupoint-pairs) and "rh" (right hand of co-occurrent acupoint-pairs). Then, the frequencies of the co-occurrence acupoint-pairs can be calculated and stored in "TABLE_IV" with fields of "lh", "rh", and "ps" (for the frequency of co-occurrent acupoint-pairs).

To be more specifically, we list the algorithm of two-dimension in Table 2.

Thus, in "TABLE_IV", the frequencies of co-occurrent acupoint-pairs can be calculated in fields of "lh" and "rh" in the descendent order of "ps".

Table 2. Algorithm of Two Dimension

```
USE TABLE_I
FOR each PMID
  k =Number_of_keyword(PMID)
  j = 1
  FOR keyword(i) (i =, 1, 2, ..., k)
    DO while j ≤ k
      keyword_Pair=keyword(i)+keyword(j)
      j = j + 1
      OUTPUT keyword_Pair INTO TABLE TABLE_III
    ENDDO
    j = 1
  ENDFOR
ENDFOR

USE TABLE_III
DO WHILE NOT EMPTY
GO TOP
  tmp_lh = lh
  tmp_rh = rh
  kw = lh + rh
  frqcy =frequency(kw)    //calculate the frequency of lh + rh
  USE TABLE_IV
    APPEND BLANK
    REPLACE lh WITH tmp_lh, rh WITH tmp_rh, ps WITH frqcy
  USE TABLE_III
  DELETE ALL lh = tmp_lh AND rh = tmp_rh
ENDDO
USE TABLE_IV
SORT ON ps DESCENDENT    //lh + rh sorted on descending order of ps
```

3 Results

3.1 One-Dimension

One-Dimension: Acupoints
Applying algorithm described in Table 1, we mined the data set of all the acupoints existed in literature. Then, we found the following list with threshold greater equal than 12. This list of acupoints are ordered by the frequency in the descendent way.

Table 3. Acupoints in the treatment of facial nerve paralysis calculated in one dimension with frequency ≥ 12

Acupoint	Chinese	ID	Frequency	Noises
Dicang	地仓	ST4	132	No
Zhongshu	中枢	GV7	129	Yes
Jiache	颊车	ST6	116	No
Yangbai	阳白	GB14	110	No
Hegu	合谷	LI4	91	No
Yifeng	翳风	TE17	87	No
Xiaguan	下关	ST7	81	No
Taiyang	太阳	-	72	No
Sibai	四白	ST2	47	No
Yingxiang	迎香	LI20	45	No
Cuanzhu	攒竹	BL2	44	No
Renzhong	人中	GV26	43	No
Zusanli	足三里	ST36	35	No
Fengchi	风池	GB20	34	No
Yuyao	鱼腰	-	33	No
Chengjiang	承浆	CV24	23	No
Sizhukong	丝竹空	TE23	18	No
Taichong	太冲	LR3	14	No
Quanliao	颧髎	SI18	12	No

Comparing this table with textbook [22], there are some differences between them.

1. All the main/kernal acupoints of treating facial nerve paralysis are included i.e., Dicang, Jiache, Yangbai, Hegu, Sibai, Cuanzhu, and Quanliao.
2. For subsidiary acupoints, most of them are included. For example, Yifeng, Fengchi, Zusanli, Shuigou, Yingxiang, Quchi, and Yuyao.
3. More interesting, there are also acupoints which are not included in textbook, yet commonly adapted in the clinical practise of acupuncture. They are Taiyang, Xiaguan, Sizhukong, Chengjiang, and Taichong. They might be a complementarity for the textbook, and we will discuss it in the later section.

One-Dimension: Chinese Medicinal Herbs
Applying algorithm described in Table 1, we mined the data set of all the Chinese medicinal herbs existed in literature, we found the following list with threshold greater equal than 10. This list of herbs is ordered by the frequency in the descendent way.

Table 4. Chinese medicinal herbs in the treatment of facial nerve paralysis calculated in one dimension with frequency ≥ 10

PinYin	Latin Name	Chinese	Frequency	Noise
Chuanxiong	Ligusticum chuanxiong Hort.	川芎	31	No
Fuzi	Radix Aconiti Lateralis Preparata	附子	30	Partically
Jiangcan	Bombyx Batryticatus	僵蚕	30	No
Quanxie	Scorpio	全蝎	28	No
Baifuzi	Rhizoma Typhonii	白附子	24	No
Fangfeng	Raidix Saposhnikoviae	防风	23	No
Danggui	Angelica sinensis	当归	20	No
Danshen	Radix Et Rhizoma Salviae Miltiorrhizae	丹参	20	No
Maqianzi	Semen Strychni	马钱子	17	No
Huangqi	Leguminosae	黄芪	15	No
Guizhi	Ramulus Cinnamomi	桂枝	13	No
Shengjiang	Rhizoma Zingiberis Rescens	生姜	12	No
Tianma	Rhizom Gastrodiae	天麻	11	No
Baizhi	Radix Angelicae Dahuricae	白芷	11	No
Chishao	Radix Paeoniae Rubra	赤芍	10	No

From Table 3, we found characteristics of Chinese medicinal herbs mined out in the treatment of facial paralysis. They compose the prescription of *Qianzheng San* (composed by Quanxie, Jiangchan, and Baifuzi) which is a famous formula in traditional Chinese medicine and widely used in clinical practice. As to other hers, i.e., in PinYin, "Baifuzi", "Fuzi", "Huangqi", "Guizhi", and "Shengjiang", they are used for warming yang and dissipating cold; "Chuangxiong", "Danggui", "Danshen", and "Chishao" are used for activating blood; "Jiangchan", "Quanxie", "Fangfeng", "Tianma", and "Baizhi" are used for dispelling wind to free the collateral vessels. As for toxic and acrid herbs, they are adopted for external use, such as "Maqianzi" and "Shengjiang".

One Dimension: Patterns
Applying algorithm described in Table 1, we mined the data set of all the patterns existed in literature, we found the following list with threshold greater equal than 24. They are shown in Table 3.

In this table, it is clear that there are much variety in the column tagged "Noise". By checking in the original data set of literature downloaded from SinoMed, we can see that "Tinnitus", "Vomit", "Dizziness" etc. that are tagged with "No" in "Noise" column. They are all the sensitive keywords of patterns yet not associated with facial nerve paralysis. As to "Leakage", "Anthema", and

Table 5. Patterns occurred in facial nerve paralysis calculated in one dimension with frequency ≥ 24

English Name	Chinese	Frequency	Noise
Herpes	疱疹	332	No
Paralysis	瘫痪	248	No
Leakage	漏	185	Partially
Facial distortion	口眼歪斜	171	No
Anthema	疹	171	Partially
Numbness	麻木	158	No
Headache	头痛	149	Partially
Tinnitus	耳鸣	111	Yes
Vomit	呕吐	75	Yes
Dizziness	头晕	60	Yes
Deaf	耳聋	60	Yes
Nausea	恶心	54	Yes
Otalgia	耳痛	51	Yes
Fever	发热	47	Yes
Twitch	抽搐	35	Yes
Sialorrhea	流涎	29	No
Ptosis	眼睑下垂	25	No
Hemiparalysis	半身不遂	24	Yes

"Headache" are tagged with "Partially", by checking in the original data set, they are partially associated with facial nerve paralysis.

In this table, too many noises are shown. Take "Headache" for example, by checking it in the original literature, we found that it can be filtered out by associated with "spasm", "non-headache", "tumor", "virus", "cerebral apoplexy", etc. However, by checking the keywords, these papers are tagged with facial nerve paralysis, that is, there is too much noise in the literature downloaded from SinoMed.

3.2 Two-Dimension

When the set of acupoints associated with its paper ID is ready, we applied the data slicing algorithm proposed in Table 2.

Two-Dimension: Acupoints
Applying algorithm described in Table 2, we mined the co-existed acupoint pairs, and the result is listed out by the order of frequency. When visualized, they are Fig. 1 and 2. In these figures, round nodes are connected with each other. Nodes are tagged with the name of acupoint. Numbers on the lines represents the frequencies of these two acupuncture point occurring together.

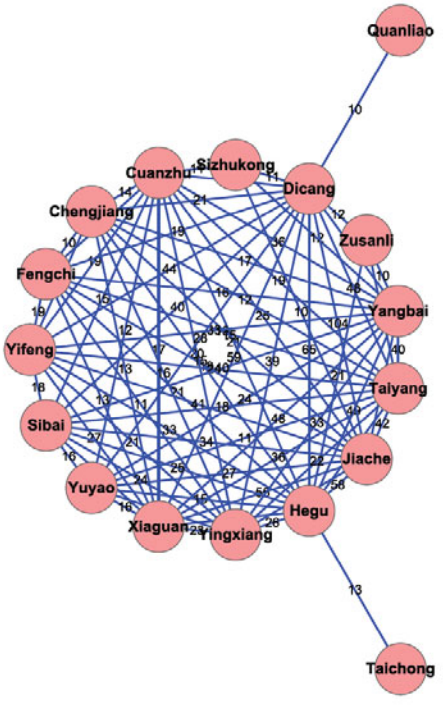

Fig. 1. Co-existed acupoint pairs with threshold ≥ 10

In Fig. 1, the threshold of frequency is 10 ($frequency \geq 10$). By this threshold, we get the acupoint set of "Yangbai", "Sizhukong", "Cuanzhu", "Jiache", "Hegu", "Taiyang", "Xiaguan", "Yingxiang", "Yuyao", "Sibai", "Yifeng", "Fengchi", and "Dichang". This set indicates the points in the treatment of facial nerve paralysis. They are mainly on meridians of Large Intestine, Stomach, Small Intestin, and Bladder. That is, in the clinical practise of acupuncture, they covered the meridians of Small and Stomach as discussed before, but not limited within them.

In Fig. 2, the threshold is updated to 40. By this, we get the acupoint set of "Jiache", "Dichang", "Yangbai", "Taiyang", "Yifeng", "Hegu", "Xiaguan", and "Sibai". They are the most commonly used acupoints in the treatment of facial nerve paralysis. Meanwhile, on checking the distribution of these acupoints, we know that they are mainly located in the vicinity of disease sites. This shows acupuncture treatment of facial paralysis mainly depend on local and nearby therapeutic effect.

Two-dimension: Chinese Medicinal Herbs

Applying algorithm described in Table 2, we mined the co-existed Chinese medicinal herb pairs, and the result is listed out by the order of frequency. When

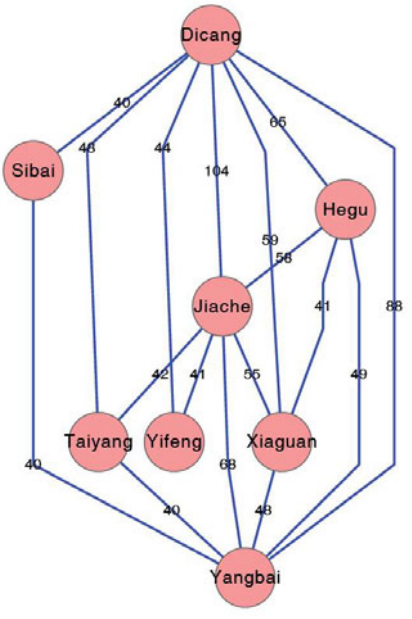

Fig. 2. Co-existed acupoint pairs with threshold ≥ 40

visualized, they are Fig. 3 and 4. In these figures, round nodes are connected with each other. Nodes are tagged with the name of herbs. Numbers on the lines represents the frequencies of these two herbs occurring together.

Fig. 3 Medication rule of facial nerve paralysis with threshold ≥ 15. It shows that Bombyx Batryticatus (Jiangcan, 僵蚕), Rhizoma Typhonii (Baifuzi, 白附子), Rhizoma Chuanxiong (Chuanxiong, 川芎), Raidix Saposhnikoviae (Fangfeng, 防 风) and Scorpio (Quanxie, 全蝎) were commonly used in facial nerve paralysis. More detailed explanation can be found in the explation of Table 1.

By this threshold, it shows that Stiff Bombyx Batryticatus, Rhizoma Typhonii, Rhizoma Chuanxiong, Raidix Saposhnikoviae, Scorpio, and Radix Angelicae Sinensis (Danggui, 当归) are commonly used in the treatment of facial nerve paralysis.

The efficacy of Bombyx Batryticatus, Rhizoma Typhonii and Scorpio is to extinguish wind and resolve phlegm, free the collateral vessels and arrest convalsions. They are ingredients of fomular *Qianzheng San* which is widely used of facial nerve paralysis. Both of Raidix Saposhnikoviae and Rhizoma chuanxiong as an important couplet medicinals play a role of dispelling wind and relieving pains. What's more, Rhizoma chuanxiong also has the efficacy of activating blood and moving qi. It corresponds to the pathogenesis of facial nerve paralysis in traditional Chinese medicine. On threshold 13, Radix Angelicae Sinensis can activate blood as well. But we can't see more herbs with the identical effect

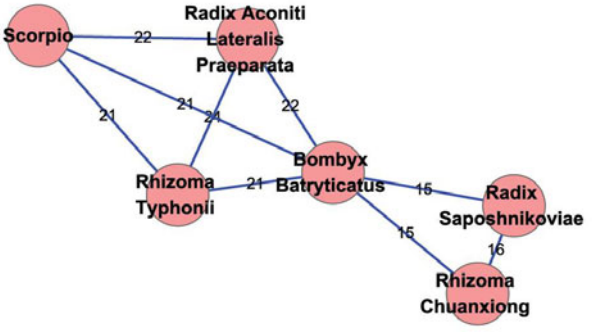

Fig. 3. Co-existed Chinese medicinal herb pairs with threshold ≥ 15

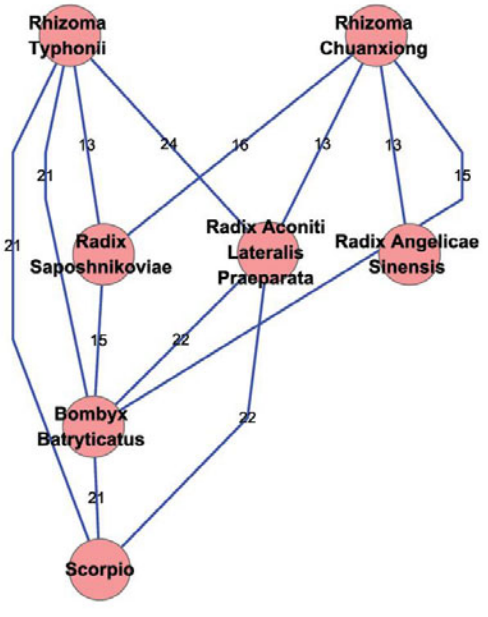

Fig. 4. Co-existed Chinese medicinal herb pairs with threshold ≥ 13

anymore in this threshold. In fact, more herbs with the function of activating blood and tonifying qi just like Flos Carthami and Radix Astragali are adopted in clinical practice. More than that, tonifying and harmonizing qi and blood conformed to the treatment principal of qi deficiency with blood stasis pattern in facial nerve paralysis. So we need to do further research on remitting the omission of general prescription and even on pattern differentiation of traditional Chinese medicine.

Two-Dimension: Patterns

Applying algorithm described in Table 2, we mined the co-existed pattern pairs, and the result is listed out by the order of frequency. When visualized, they are Fig. 5. In Fig. 5, round nodes are connected with each other. Nodes are tagged with the name of patterns. Numbers on the lines represents the frequencies of these two patterns occurring together.

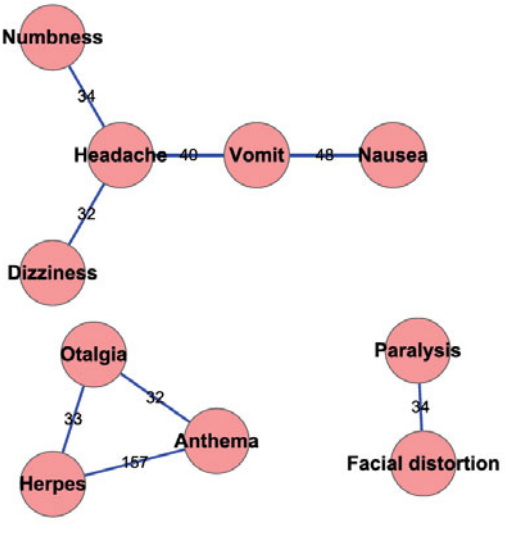

Fig. 5. Co-existed pattern pairs of facial nerve paralysis with frequency

In Fig. 5, patterns of "Headache-Vomit-Nausea" can be taken as noise according to the clinical manifestation of facial nerve paralysis. However, they are the clinical manifestation for disease of *Ramsay Hunt syndrome* [4]. This is caused by the over tagging of keywords in the literature of SinoMed. There are sub-networks are of the same kind, i.e., triangle sub-network of "Otalgia-Herpes-Anthema" and sub-network of "Paralysis-Facial distortion".

Although there are noise in the literature, we will develop other techniques for the further pre-treatment of the data set downloaded.

4 Conclusion and Discussion

Compared the data mining results of reviews and clinical observations [15, 16, 27, 24, 5, 11, 8, 9, 13, 14] with the textbooks [21, 23, 22], we found out that:

1. **Table 3 covers all the main points and most of the subsidiary acupoints.** This can be checked by comparing with this textbook of acupuncture [22], the high quality of mining result lies in the specifieness of the name of acupoints (at least most of them).
2. **Herbs mined out in Table 4 in the treatment of facial nerve paralysis are reasonable.** Compared with the theory of traditional Chinese medicines, most of the results are good. Of course, there is noise existed, i.e., "附子"(Radix Aconiti Lateralis Preparata) can be taken as the substring of "白附子"(Rhizoma Typhonii).
3. **Much items of noise existed in the mining result which can be seen in Table 5.** Compared with the patterns known for facial nerve paralysis, the result mined out in Table 3 is not good. By checking them in original data set, we found that the main reason is the low quality of tags associated with papers: too many tags with general meaning associated to literatures which is the main reason of noise existed in patterns. In order to tackle this problem, more rules based on professional knowledge should be constructed and applied in the future mining process.
4. **Based on the whole mining results, we can see that the antinoise is built on the specifieness of filters of sensitive keywords.** By Table 3, 4 and 5, we know that more specific the filters are, the more correct the mining results.
5. **The algorithm, named *two dimensions data slicing*, might be useful in mining the literature of traditional Chinese medicine.**

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