Team Number :	0418

Problem Chosen :	A

2017 APMCM summary sheet

Summary：

In this paper, through analyzing the quality of sleep of special groups, qualitative and quantitative factors that affect the quality of sleep are obtained, and the relationship between the patient's condition and the quality of sleep and the method of diagnosing the quality of sleep in different patients are analyzed and proposed. Finally, according to the medical relevant knowledge, inferred a reasonable method of scheduling sleep time, put forward the following model.

Question 1:

According to the data given in data table 1, for a variety of sleep quality factors, we use the stratified analysis method, that is, firstly, we analyse two categories: age and sex to study the use of 2X2 diary table and univariate γ^2 analysis methods, using the spss software to get the qualitative impact of age and gender on the quality of sleep: age and gender have an impact on the quality of sleep, but little effect. So we can put the remaining four factors as a whole analysis of its impact on sleep quality, take the spss bivariate analysis to get qualitative relationship, the discharge of the reliability of sleep quality. And then take the remaining three factors to take multiple regression analysis, get the remaining three factors on the quality of sleep function, which can be psychoticism and nervousness are important for the quality of sleep, and character have little effect on the quality of sleep Conclusion.

Question 2:

The second question asked us to analyze the relationship between symptoms and quality of sleep,sleep lantency and other factors, and to make judgments on the disease according to factors such as the quality of sleep.We analyzed the data in Schedule 2 ,which with 122 associated symptoms and lots of data.To simplify the calculation, we took Anxiety (400 samples), Anxiety Disorder (800 samples), Bipolar Affective Disorder (132 samples), Depression (1472 samples), Mixed Depression and Anxiety (368 samples), Sleep Disorders (1702 samples) to analyze.Calculate with BP neural network with momentum factor added.Due to various limitations,for example, if the amount of data is too large, the convergence of the neural network will be seriously affected. Therefore, a simple random sampling method is adopted to extract 500 data for calculation.We notice that the sample

size for psychiatric disorders, including anxiety disorders, bipolar disorders, and sleep disorders, is similar to the sample size for the other three categories of disease, the analysis was performed in two steps.The first step is to analyze whether the symptom is a kind of psychiatric disorders .The second step is to subdivide the disease in the major categories to get the final result.The main consideration in doing so is that even if it is impossible to predict exactly what kind of diseases, it can also give a certain degree of judgment as to whether it is a disorder of mental disorders.

Question 3:

As for the third question, if we use the result of the second question, we will diagnose it directly to get the final result.

Question 4:

The subject of this study is the normal population, to arrange the sleep plan of the normal population need to consider many factors. Here we only consider the factors mentioned in the first question to be taken into account, and the results obtained from the first question are brought into the fourth question. At the same time, three kinds of sleep are obtained through the analysis of the found information and the living habits of the present people Time arrangements, and the use of analytic hierarchy process to assess its effectiveness, so as to get the most effective sleep plan.

1. Introduction

The World Association of Sleep Medicine has set March 21 as World Sleep Day every year since 2001 so as to draw attention to the importance and quality of sleep. The mental state of a whole day depends on the sleep quality last night, and high sleep quality naturally ensures people to be energetic. According to statistics, however, the rate of insomnia in Chinese adults is as high as 38.2%, and the rate of insomnia in adolescents is rising meanwhile. In general, it belongs to the category of insomnia if the time to fall asleep is more than 30 minutes, so we believe many participants are also the insomniac. Long-term insomnia makes people feel tired, lack of energy in the whole day, and cannot concentrate attentions, so the efficiency of working and study is accordingly low. Severe insomnia even will cause autonomic nerve function disorder, resulting in imbalance and various problems of various systems in the body.

Many factors affect insomnia, and they can generally be divided into objective and subjective factors. Objective factors are environmental changes, tea or coffee before going to bed, and so on, and subjective factors are generally the pressure of life, emotional loss, mental excitement and other spiritual factors. However, the brains of young people in the period of growth and development are extremely prone to fatigue due to learning and work stress. Therefore, they must pay special attention to bed rest to ensure a good and healthy body.

Human body's sleep quality and data of various indicators possibly affecting the sleep quality are given in Annex I. (Source and test number are not indicators)

The relevant scores for sleep conditions are given in Annex II ("0" for good, "1" for normal, "2" for poor, and "3" for very poor), the higher the score, the worse the sleep condition.

(1)Analyze the relationship between the indicators given and the quality of sleep

according to the data in Annex I, if there is no correlation between one or several indicators and sleep quality, find it or them out and delete.

(2)Analyze the relationship between the diagnosis results and sleep.

(3)Assuming you are a doctor, what diagnosis would you make to the patient based on the data in Annex III? Give your diagnosis result.

(4) How to scientifically arrange our rest time for the health of the body? Develop appropriate sleep program and evaluate its effectiveness.

2. Modeling preparation

a. It is assumed that the psychoticism, reliability, nevousness, and character of different individuals are related to the sex and age of the subjects.

b. It is assumed that the nature of different individuals is unaffected by other individuals.

c. It is assumed that all of the individual data come from the same population.

d.

e. All the data on criminal case study are correct and accurate.

3. Definitions and key terms

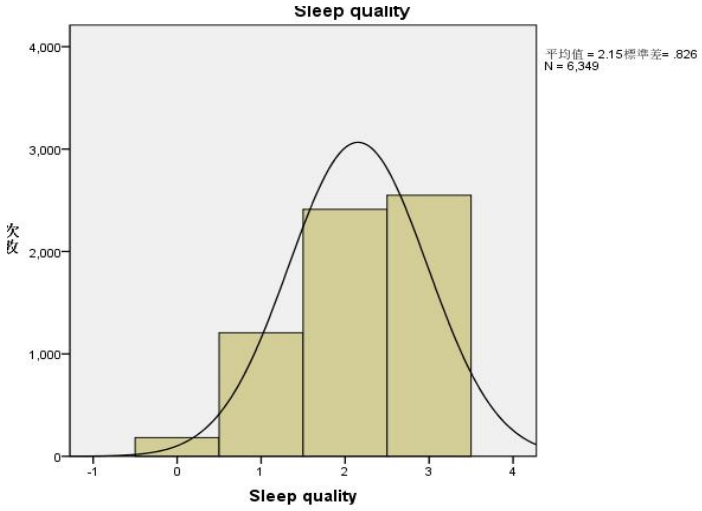
SNQ_I	Sleep Quality Index for illness people $SNQ_I \in N \quad SNQ_I \in [0,3]$
SNQ_N	Sleep Quality Index for normal people $SNQ_N \in N \quad SNQ_N \in [0,3]$
X_P	the index of psychoticism
X_C	the index of character
X_N	the index of nervousness
arf	Momentum factor
lr	Learning speed
maxe	The maximum number of learning
W_1	The weight between the input layer and the hidden layer
B_1	Threshold between input layer and hidden layer
W_2	The weight between the output layer and the hidden layer
B_2	The threshold between output and hidden layer
$C.I.$	the degree of inconsistency
$R.I.$	average random consistency indicator
$C.R.$	the consistency ratio

4. Task 1:Analysis of the factors that affect the quality of sleep

The quality of sleep on the human body has a great impact. The data given in the attachment mentions the impact of factors on sleep quality. Given the different meanings of these independent variables and the data given in the annex, Therefore, our key to the problem is to devide this elements into several groups to consider the impact of factors approach. In our opinion, the first date table can be grouped by sex and age test, test methods including taking the expected variance of intuitive comparison, using the second league table and wielding single factor analysis. And then grouped according to the relevant parameters, using SPSS for bivariate correlation analysis. Finally, the relevant factors were multivariate linear fitting to determine the correlation between the factors and sleep quality rankings.

a. Analyse

First of all we use the spss software to handle and picture the graphic of the data (picture 1.1) and found that it does not meet the normal distribution, the reason is very simple, is the study of the particularity of the data given to the data object of the clinic , only the sick people will go to the clinic, so the poor quality of sleep are more than the general quality of people who sleep better.



(picture 4. 1)

b. Discuss the impact of gender and age on sleep quality.

Gender statistics for different sleep quality

Sleep quality	Male		Female		Sum	
0	73	3.50%	109	2.56%	182	2.87%
1	426	20.44%	780	18.29%	1206	19.00%
2	835	40.07%	1577	36.98%	2412	37.99%
3	750	35.99%	1799	42.18%	2549	40.15%
Sum	2084	100.00%	4265	100.00%	6349	100.00%
Mathematical expectation	2.0854		2.1878		2.1542	

(table 4.1)

From the table we can get that by separating the data of the two genders and separately treating the male and female samples, it is easy to get the ratio of the number of sleep quality to the total number of the gender samples and then calculate the expectation of the quality of sleep for both men and women. According to the statistical results shown above, the quality of sleep of both men and women are about 2.1, the difference is small, the gender of the statistical characteristics of sleep quality is not obvious.

Because the quality of sleep in the subject is divided into four categories, it can now be assumed that the same quality of sleep 0,1. 2,3 poor quality of sleep. First use the binary table for analysis.

We first classify the quality of sleep into "qualified" and "unqualified" categories, in which the sleep quality of the number "0" and "1" sleep quality is "qualified" and the sleep quality of the number is "2" and "3" Quality of "unqualified", statistics 2X2 diary table.

Sleep quality	Sex		Row sum
	Male	Female	
Qualified	499(a)	889(b)	1388
Unqualified	1585(c)	3376(d)	4961
Column sum	2084	4265	6349

(table 4.2)

The correlation coefficient is calculated according to the table(tabble4.2):

$$K^2 = \frac{\mathrm{n}(ad - bc)}{(a+b)(a+c)(b+c)(b+d)}$$

The result is K2 = 2.86X10-5, the correlation coefficient is almost 0, and the analysis result has no effect on the quality of sleep.

Taking into account the quality of sleep and gender as discrete data, so we use univariate γ^2 analysis. The result is as follows:

睡眠质量*性别 交叉列表

			性别		總計
			男	女	
睡眠质量	0	計數	73	109	182
		睡眠质量 內的 %	40.1%	59.9%	100.0%
	1	計數	426	780	1206
		睡眠质量 內的 %	35.3%	64.7%	100.0%
	2	計數	835	1577	2412
		睡眠质量 內的 %	34.6%	65.4%	100.0%
	3	計數	750	1798	2548
		睡眠质量 內的 %	29.4%	70.6%	100.0%
總計		計數	2084	4264	6348
		睡眠质量 內的 %	32.8%	67.2%	100.0%

(picture 4.2)

卡方測試

	數值	df	漸近顯著性（2 端）
皮爾森 (Pearson) 卡方	24.592[a]	3	.000
概似比	24.632	3	.000
有效觀察值個數	6348		

a. 0 資料格 (0.0%) 預期計數小於 5。預期的計數下限為 59.75。

對稱的測量

		數值	大約 顯著性
名義變數對名義變數	Phi	.062	.000
	克瑞瑪 V (Cramer's V)	.062	.000
有效觀察值個數		6348	

(picture 4.3)

The results show that the pearson value less than 0.05, indicating that the two are related, but the correlation is not high. Meanwhile the theoretical frequency of less than 5 lattice ratio can not exceed 20%, otherwise the result will be unreliable. It can be seen from the annotation results that the theoretical frequency of no data is less than 5 (the minimum value is 59.75), and the single factor analysis result of spss is reliable. Since we are doing a qualitative analysis, we can conclude that the above analysis is accurate.

Similarly, in accordance with the medical classification of sleep on the age group, the

study is divided into [15,35], [35,44], [44,90] three intervals for research, research methods with the same age analysis Method, the conclusion reached is also related to the age of subjects and sleep quality, but the correlation is not high.

c. Study the impact of other factors on sleep quality

Through the conclusion of the second step, the age and gender of the subjects have some influence on the quality of sleep, but little effect, so in the analysis of the impact of other factors, we choose to directly ignore the age and gender on the quality of sleep, The remaining four factors for qualitative analysis, the use of Spss bivariate analysis of its analysis. Spss operation results are as follows:

相關

		Reliability	Psychoticism	Nervousness	Character	Sleep quality
Reliability	皮爾森 (Pearson) 相關	1	-.182**	-.355**	-.002	.017
	顯著性（雙尾）		.000	.000	.876	.179
	N	6349	6349	6349	6349	6349
Psychoticism	皮爾森 (Pearson) 相關	-.182**	1	.039**	.019	.078**
	顯著性（雙尾）	.000		.002	.138	.000
	N	6349	6349	6349	6349	6349
Nervousness	皮爾森 (Pearson) 相關	-.355**	.039**	1	-.185**	.083**
	顯著性（雙尾）	.000	.002		.000	.000
	N	6349	6349	6349	6349	6349
Character	皮爾森 (Pearson) 相關	-.002	.019	-.185**	1	-.031*
	顯著性（雙尾）	.876	.138	.000		.012
	N	6349	6349	6349	6349	6349
Sleep quality	皮爾森 (Pearson) 相關	.017	.078**	.083**	-.031*	1
	顯著性（雙尾）	.179	.000	.000	.012	
	N	6349	6349	6349	6349	6349

**. 相關性在 0.01 層上顯著（雙尾）。

*. 相關性在 0.05 層上顯著（雙尾）。

（picture 4.4）

From the generated tables, we can see that in addition to the sig number of reliability more than 0.05, and the other three factors sig number less than 0.05, which shows that the other three passed the significance test, in other words，the three factors have a correlation with the quality of sleep. As for the P index value is not large, because the initial data of the screening is not accurate enough. However, in this step we only use SPSS to make qualitative analysis of the data, identify the relevant factors and then analyze it by other means. As

these three factors are all continuous data, so that as following we use multiple linear regression analysis to analysis these three factors to determine the size of the influencing factors.

When calculating multiple regression analysis, we first standardize the data to be analyzed before using spss software to make the regression analysis, the results as shown below:

變異數分析[a]

模型		平方和	df	平均值平方	F	顯著性
1	迴歸	81.590	3	27.197	27.538	.000[b]
	殘差	6266.410	6345	.988		
	總計	6348.000	6348			

a. 應變數: Zscore: Sleep quality

b. 預測值：（常數），Zscore(Character), Zscore(Psychoticism), Zscore (Nervousness)

係數[a]

模型		非標準化係數		標準化係數	T	顯著性
		B	標準錯誤	Beta		
1	（常數）	-5.439E-15	.012		.000	1.000
	Zscore(Psychoticism)	.075	.012	.075	6.030	.000
	Zscore(Nervousness)	.077	.013	.077	6.054	.000
	Zscore(Character)	-.018	.013	-.018	-1.457	.145

a. 應變數: Zscore: Sleep quality

殘差統計資料[a]

	最小值	最大值	平均數	標準偏差	N
預測值	-.4215909	.3428416	.0000000	.11337031	6349
殘差	-2.87316012	1.39879560	.00000000	.99355280	6349
標準預測值	-3.719	3.024	.000	1.000	6349
標準殘差	-2.891	1.408	.000	1.000	6349

a. 應變數: Zscore: Sleep quality

(picture 4.5)

From the figure we can see that the average of the residual statistical data are 0 shows that the original data has been standardized, then the coefficient table can be regression equation：

$$SQN_I = -5.439e^{-15} + 0.075X_P + 0.077X_N - 0.018X_C \qquad (1)$$

The analysis of the regression equation, we can get the value of the constant term is very small, so the variables of each variable can be regarded as valid, based on this conclusion we can draw psychoticism and nervousness of sleep quality is greatly affected, followed by the character influences.

5. Task 2:Analyze the relationship between the diagnosis results and sleep.

Psychiatric disorder refers to the disorder of the brain's functional activity that leads to various degrees of impairment of mental activity such as cognition, emotion, behavior and will.Common emotional disorders, brain organic mental disorders are widely seen.Pathogenic factors in many ways: genetic, personality characteristics and physical factors, organic factors, social environmental factors and so on.Anxiety disorders and anxiety are similar in name,.But it should be noted that anxiety disorders are widely used in the diagnostic criteria for mental disorders in the United States, including generalized anxiety, acute anxiety episode, phobia, post-traumatic stress disorder, acute stress disorder, obsessive compulsive disorder,which is different to the anxiety. We noticed that in addition to the symptoms of depression ， there are depressive episodes, mild depressive episodes, moderate depressive episodes and other results, it is speculated that depression and anxiety should be the same, just mental illness, but did not constitute a "disorder".These are important because the six major categories of diseases that are identified in this paper are anxiety, depression, mixed depression and anxiety, anxiety disorders, bipolar affective disorder, and sleep disorders, broken down into two broad categories: mental disorders and non- Mental disorders. There must be some differences in the pathology between the two, so it is more meaningful to discuss the two separately.

Medical knowledge has its own characteristics: a disease is manifested as a group of symptoms, different diseases can show different symptoms, and the same symptom may be a manifestation of a variety of diseases.Due to the complexity of the disease, the same disease can also have atypical forms of realization, so the regularity of the disease is more difficult to grasp, which requires experts.Medical experts' ways of thinking can be summed

up as follows: Experts try to get all the possible symptoms through inquiry and various examinations, and then match the symptom characteristics obtained with the knowledge of disease types in the brain to obtain the most suitable result[2].This process of thinking and matching is very similar to the training process of neural network, so we use artificial neural network to analyze.

a. The first step in the process

1. Classification and numbering.

First of all, 500 random data were divided into two categories: anxiety, depression, anxiety and depression as a category numbered 1; Anxiety disorders, bipolar disorders, sleep disorders into a category numbered 0. It should be noted that 0 and 1 are just numbers, and does not mean that the size of the relationship.

2. Neural network training.

After debugging, the momentum factor arf = 0.01, learning speed lr = 0.001, the maximum number of training maxe = 50000.There is a hidden layer. The incentive function is logstic function, the number of hidden layer neurons is 15. The final results W1, W2, B1, B2 are obtained. Take the test sample and input the same sample to be tested. The result is as follows:

W1						
-0.33	1.59	3.1	-0.86	-6.37	-2.26	1.36
-3.99	-1.16	-2.47	2.66	-1.08	4.97	-1.28
0.38	-3.75	0.13	0.15	-0.06	-1.79	-2.75
1.31	-5.24	5.96	-2.52	5.12	7.41	-5.33
-1.92	-0.47	0.86	0.78	-2.44	0.08	-2.86
-3.67	-0.15	-7.39	2.83	-8.63	0.34	4.86
-0.94	-1.55	-2.33	-0.04	-1.09	3.17	1.93
-4.41	-0.47	-6.18	1.9	-6.02	-2.81	4.1
-0.22	-3.12	2.27	-0.16	3.73	4.94	0.33
2.63	-4.17	-2.96	0.29	-6.44	2.9	2.81
-2.67	4.87	0.36	1.21	-1.85	-2.65	2.33
0.72	-4.55	3.84	-2.63	1.1	-1.61	5.54
-0.56	1.13	-5.11	-0.09	4.22	5.41	1.14
-5.02	3.3	5.12	2.33	-10.17	1.87	-5.57
0.6	-0.62	0.09	-0.12	0	-4.61	2.17

Transpose matrix of W2		B1		B2
1.94		-6.31		0.56
-2.14		-0.94		
-2.68		-0.41		
-2.42		-5.14		
4.32		-0.75		
2.6		-5.21		
4.35		2.22		
-3.37		-5.31		
2.43		-2.23		
-2.37		2.73		
-2.27		-4.45		
-1.88		0.14		
-2.39		-2.36		
-2.13		-4.8		
4.22		-4.53		

3. Accuracy analysis.

Take the test sample from input training samples, the number that the test results obtained with the number of output values is：

$$N = 433$$

The accuracy is:

$$433/500 = 86.6\%$$

So this is the first step of the neural network and its result.

b. The second step in the process

Since the classification of the disease has been made, the next step is to find out the specific symptoms in the classification.

1. Classification and numbering.

There are two types of disorders (mental disorders and non-mental disorders) and they are different categories:

	Non-mental disorders			Mental disorders		
diagnosis	Depression	Anxiety	Depression and anxiety	Bipolar Affective Disorder	Anxiety disorder	Sleep Disorder
Feature vector	[0,1]	[1,0]	[0.5,0.5]	[0,1,0]	[0,0,1]	[1,0,0]

It should be noted that the final results of the neural network can not only be an integer, so the value of the results of both are different.

For non-mental disorders, when the difference between two vectors is less than 0.2, it is determined that depression and anxiety, otherwise according to the close value.

For mental disorders, the largest column in the result vector is set to 1 and the rest is set to 0 to get the final result.

2. Neural network training.

After debugging, take arf = 0.01, lr = 0.001, maxe = 200000. The result is:

Mental disorders:

W1						
-1.52	-3.1	-1.5	-1.44	2.22	1.62	-0.72
0.21	-2.96	4.04	-2.25	3.09	1.73	-2.11
-5.74	0.46	18.11	-6.47	6.51	8.1	-0.71
-7.73	8.34	-15.11	3.23	7.97	6.16	9.47
4.92	-6.54	4.85	-1.62	-2.9	3.91	2.6
0.93	-0.24	7.1	-0.25	-3.04	3.38	7.43
11.46	9.24	1.71	7.71	-7.99	13.56	-3.99
4.99	11.94	5.68	-0.08	2.61	-6.58	7.58
-12.86	13.69	-4.86	-1.8	1.66	4.76	8.75
-4.34	8.72	3.72	-5.5	-0.45	2.23	2.76
6.57	-10.81	-2.77	3.1	3.91	-10.86	-3.84
1.96	2.47	2.71	0.01	-0.43	-1.11	-0.51
-0.02	0	2.83	4.61	7.88	-0.8	1.23
-1.4	0.79	-1.01	4.96	5.92	-1.07	-1.98
-9.81	-0.34	-2.99	-5	1.59	1.15	10.12

Transpose matrix of W2			B1	B2
-5.06	-0.16	5.23	-0.54	3.46
4.14	0.18	-4.32	1.05	-1.22
-3.21	-0.07	3.28	0.04	-3.24
2.35	-0.12	-2.24	0.44	
-2.39	0.06	2.33	6.76	
1.71	-0.05	-1.66	2.97	
1.9	0.04	-1.95	-4	
-1.74	-0.04	1.79	-6.79	
-1.82	0.11	1.71	0.64	

2.03	-0.07	-1.97	-2.27	
2.2	-0.09	-2.12	1.75	
-4.84	0.32	4.52	0.6	
2.51	-0.12	-2.38	0.49	
-3	0.16	2.83	-0.5	
-1.83	0.33	1.49	-1.03	

Non-mental disorders:

W1						
-2.29	1.66	-0.01	0.15	-4.33	1.61	2.92
2.71	2.64	0.2	1.13	-1.85	-1.15	2.97
3.18	-2.83	0.45	4.53	-1.41	-8.24	3.88
-6.6	-4.32	4.72	-5.64	3.31	3.5	-1.11
-1.07	6.07	5.19	1.79	-1.85	-2.09	0.04
1.52	1.77	-0.8	-2.43	2.76	-1.23	0.29
13.54	7.23	2.67	0.17	-9.46	3.4	5.36
1.56	-0.62	0.52	2.66	2.68	-0.65	-3.53
5.61	0.26	-1.73	4.82	-4.5	-2.67	-1.47
-2.82	-6.21	-5.46	0.78	1.18	4.78	0.8
0.82	13.86	9.78	6.09	-4.97	-4.76	0.05
-2.78	2.07	1.19	-0.59	-1.61	2.29	-1.17
5.12	0.92	-3.85	6.36	-1.08	-7.51	6.56
-3.61	-3	-1.62	-1.19	2.94	1.04	-2.48
4.49	3.79	-8.07	0.95	3.54	1.19	-2

Transpose matrix of W2		B1	B2
-2.05	2.04	-2.36	3.76
-4.2	4.21	1.99	3.76
-2.05	2.06	-0.81	
-2.39	2.38	-5.75	
5.25	-5.27	-2.36	
2.52	-2.52	-0.86	
-0.88	0.89	-9.79	
-3.19	3.19	3.37	

2. 23	−2. 23	−2. 09	
1. 86	−1. 85	7. 2	
−4. 2	4. 21	−5. 55	
2. 48	−2. 48	−0. 9	
1. 99	−1. 99	−2. 19	
−2. 27	2. 27	0. 91	
−2. 06	2. 06	−0. 76	

3. Accuracy analysis.

For mental disorders, the number that the output values are same with the test sample values is:

$$N = 213$$

The accuracy rate is:

$$213/240 = 88.75\%$$

For non-mental disorders diseases, the number that the output values are same with the test sample values is:

$$N = 218$$

The accuracy rate is:

$$218/260 = 83.8\%$$

6. Task 3:Diagnose the condition

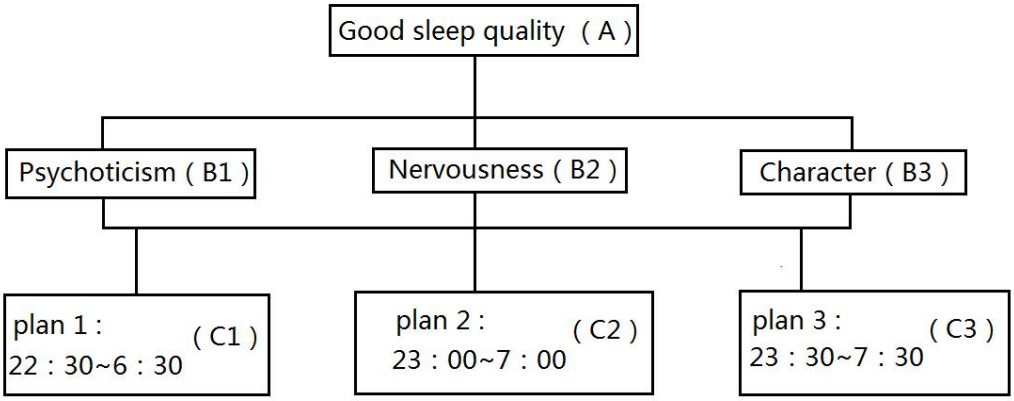
We use t result which we get in the second question , that is, the weight and the threshold, to deal with the third question.

The following is our judgment:

Number	Whether is psychiatic disorder	Diagnosis
1	yes	Anxiety Disorder
	no	
	yes	
	no	
	no	
	yes	
	yes	
	no	
	yes	
	no	
2		Depression
3		Sleep Disorder
4		Depression
5		Depression
6		Sleep Disorder
7		Sleep Disorder
8		Depression
9		Sleep Disorder
10		Depression

7. Task 4:Scientifically arrange for body breaks and develop appropriate sleep plans

Applying AHP to evaluate sleep patterns and quality of sleep, we can use the good sleep quality as the target level and the factors based on the problem as the criterion level, and use our summarized sleep arrangements as the program level. The available hierarchical structure analysis model is as follows：



The three sleep plans are based on roughly three criteria for searching for modern habits and health conditions.

For the quality of sleep of normal people, we can also analogy analysis of hospital outpatient research object, analysis of factors, factors, and the relationship between the factors, as formula (1) to the patient's sleep quality index formula, so with proper corrections we can get a positive index of sleep quality for normal people as follows:

$$SQN_N = -3.265e^{-15} + 0.043X_P + 0.060X_N - 0.016X_C \qquad (2)$$

First of all, from the sleep quality index evaluation formula(2), we can get $A-B$ comparison matrix:

$$A = \begin{bmatrix} 1 & 3/4 & 5/2 \\ 4/3 & 1 & 2 \\ 2/5 & 1/2 & 1 \end{bmatrix}$$

Theoretically, if the matrices are perfectly consistent pairs of matrices, there should be $\forall_{i,j,k}$, , $A_{ij}A_{jk} = A_{ik}$. But in fact, it is not possible to construct matrices to satisfy the above equations when comparing matrices .So back to the next, we do the Consistency check for the $A-B$ comparison matrix.

1.Calculate the degree of inconsistency ($C.I.$) that measures the contrast matrix A .

$$C.I. = \frac{\lambda(A) - n}{n-1} = 0.01455$$

2.Find the corresponding average random consistency indicator($R.I.$),we can get 3 orders $R.I. = 0.52$, Calculate the consistency ratio($C.R.$):

$$C.R. = \frac{C.I.}{R.I.} = 0.0279 < 0.1$$

$C.R.$ shows that the degree of inconsistency of matrix A is acceptable. In this case, the eigenvector corresponding to the largest eigenvalue of the matrix is

$$U = (0.6338, 0.7127, 0.3006)^T$$

By normalizing this eigenvector, the weight vector is obtained：

$$U = (0.3848, 0.4327, 0.1825)^T$$

3.Construct a $B-C$ comparison matrix:(Based on the quality of modern people's sleep and living conditions)

$$B_1 = \begin{bmatrix} 1 & 5/3 & 7/4 \\ 3/5 & 1 & 3/2 \\ 4/7 & 2/3 & 1 \end{bmatrix} \qquad B_2 = \begin{bmatrix} 1 & 5/6 & 7/4 \\ 6/5 & 1 & 2 \\ 4/7 & 1/2 & 1 \end{bmatrix} \qquad B_3 = \begin{bmatrix} 1 & 3/4 & 7/4 \\ 4/3 & 1 & 6/5 \\ 4/7 & 5/6 & 1 \end{bmatrix}$$

By calculating we can get the eigenvalues, eigenvectors, consistency indexes and consistency ratios of the $B-C$ comparison matrix:

	$B1$	$B2$	$B3$
B - C Weights	0. 4581	0. 3621	0. 3595
	0. 3095	0. 4275	0. 3841
	0. 2324	0. 2103	0. 2564
B - C Maximum eigenvalue	3. 0142	3. 0003	3. 0493

$B-C$ $C.I.$	0. 0071	0. 0001	0. 0247
$B-C$ $R.I.$	0. 52	0. 52	0. 52
$B-C$ $C.R.$	0. 0137	0. 0002	0. 475

The above consistency ratios($C.R.$) are all less than 0.1, and it can be determined that the judgment matrix has satisfactory agreement.

For the highest goal, the highest level of the overall ranking is the total order of its hierarchy. In evaluating the data, we need to calculate the combination weight vector for the decision-making problem. The result is shown in the figure below:

	$B1$	$B2$	$B3$	The total order W
$C1$	0. 4581	0. 3621	0. 3595	0. 3986
$C2$	0. 3095	0. 4275	0. 3841	0. 3742
$C3$	0. 2324	0. 2103	0. 2564	0. 2272

Finally get the combination of weight vector：

$$\omega = (0.3986,0.3742,0.2272)^T$$

So we can get the results from the analysis, the first plan and the second plan share a larger and similar weight, indicating that they can play a better sleep effect.

8. Model Analysis

Advantages:

Question 1:

The first question adopts a stratified thinking, considering the influencing factors from large to small, avoiding the accidentality in the multivariate analysis, and the result is more authentic. Three methods were tested for age and gender, and the test results were similar. By using chi-square test, we get the effective testing of discrete variables to avoid the traditional regression test can only test the continuous volume of the problem. Bivariate analysis of the

remaining four factors, excluding one of the factors, and then remaining three factors of multiple regression analysis, so that the approximate accuracy of the results.

Question 2:

1. Reasonable choice of subjects, to avoid falling into too many symptoms ,which is too difficult to analyse, while making the results more reliable.
2. The second question was modeled using an artificial neural network ,which is similar to medical experts' way of thinking, resulting in more accurate results than the general multiple linear regression method. At the same time, the adjustment of neural network parameters is more flexible. And the addition of the momentum factor, make the results obtained by the network more easily reach the global minimum
3. Using a two-step neural network, you get at least one general result rather than the wrong result. And the second step to get detailed results also avoids the disadvantages of neural networks that are not good at dealing with large amounts of data. Reasonable division of the type of disease, make the two-step neural network computing becomes meaningful.

Question 4:

The fourth question to go through the data and access to look for the characteristics of modern people's sleep habits are roughly three types of sleep time listed. Then using AHP, make full use of the conclusions of the first question, using the idea of being too-normal distribution of sleep quality, to correct the sleep quality index function and obtain an approximate objective conclusion. Using AHP, we got a better sleep schedule.

Disadvantages:

Question 1: The first question of spss software due to the use of unskilled, can not be effectively removed from the data, which can not play spss greatest utility.

Question 2:

1. The amount of data selected is too little, only 10% of the original data.the overall not

necessarily have a good reflection.It may not have a good reflection of the overall situation.

2. We only selected six diseases for analysis, can not get more detailed results, wasting a lot of information.

3. The neural network is calculated in two steps, doubling the computation time, and debugging is even more troublesome.

Question 4:

The conclusions drawn are not very accurate because of factors that affect the quality of sleep, as well as inadequate findings and subjectivity of the survey.

Quoted literature：

[1] Wensheng zhao, Survey Of Sleep And Related Factors Among Students In Medical College, www.CNKI.net, 2017-11-25.

[2] Xia Zhao,BP Neural Network and Application in Medical Field, www.CNKL.net, 2017-11-25.

[3] Lingzhuo Ling,Concerned with young people, concerned about sleep, www.CNKI.net, 2017-11-25.

[4]Shengguan Ma,Analysis on Sleeping Time among Chinese Population, www.CNKI. net,2 017- 11-2 5