Team Number	:80284

Problem Chosen :	B

2018 APMCM summary sheet

Retain Talent, Retain Future

Abstract

Talents are the source of power for urban development. The core goal of this paper is to establish a scientific urban talent demand model through relevant data in the job market, and provide suggestions and opinions for talent cultivation.

Firstly, after classifying and summarizing the data in annex, we analyze the talent demand from the aspects of total talent demand, education background, job demand in various sectors. In the **qualitative analysis**, we illustrate features by studying trends and changes, comparing proportion, similarities and differences. In the **quantitative analysis**, **Association Analysis of Apriori Algorithms** is used to find correlation between indexes. We also do commonness analysis based on the **K-means clustering analysis** and Q-cluster analysis. With **global and partial analysis**, we find the talent demand has a cyclical fluctuation as a whole, and the feature that job demand exceeds supply is very apparent.

Secondly, **linear programming model** is established to describe the relationship between demand and supply of talents, showing talent demand and employment situation. With the **Residual Independence Test**, Variance Analysis, **T-test**, the rationality of quantification has been demonstrated. Based on above conclusions and **Exponential Smoothing Method**, prediction problem of talent demand and supply can be solved. We conclude that demand of tertiary industry will increase in the future, service industry like sales, will be more prosperous.

Thirdly, from **horizontal and vertical analysis** of industry proportion, trend, market demand and employment rate in different sectors and years in A city, we find it has higher employment rate, developed tertiary industry, enormous demand, and high economic position, which is similar to developed coastal city like province-level municipality, Beijing, Shanghai.

For problem four and five, employment directions are illustrated by the aspects of employment intentions and employment factors. We find graduates prefer further study and taking civil service examinations by **AHP evaluation model**. In addition, comparing the results of **PCA and GRA methods**, we conclude that comprehensive qualities, vocational certificates are vital to employment ability. According to above conclusions, we put advice for A city and school authorities.

Finally, we do the **adaptive analysis and test** for model, proving the rationality of results. Additionally, **Expert modeler** and **Triple exponential smoothing** are used to optimize results.

To sum up, with intelligent use of analogy skill, global and partial analysis, qualitative and quantitative analysis, our models have advantage of great robustness and rationality.

Keywords: Apriori Exponential Smoothing Method Expert Modeler Talent Demand

Content

1. Introduction

1.1 Background

In recent years, inviting wisdoms and attracting talents has been one of the highlights of many cities. Beijing, Shanghai, Wuhan, Chengdu, Xi'an and Shenzhen are actually competing for talents with various attractive policies. Talents are the driving force for urban innovation and development because they have the ability to learn better skills, create better products, and master better management methods in less time. Talents are the main driving force for urban innovation communication because innovation diffusion is achieved through the promotion of processes and new technologies by high-quality talents. In cities today, talents are recruited via the internet, on-campus job fairs, and open recruitment events in addition to local talent markets. The study of talent demand is conducive to our full understanding of the market, which has important social significance.

1.2 Restatement of the Problem

In order to study talent demand in the market, the following issues were solved based on the data in Annexes:

(1) According to the attached data, model and analyze the talent demand of the "job market of A-City" from job demand, the desired profession, and the desired educational background.

(2) Based on the data attached and other necessary data available, build a model of the actual talent demand of A-City with from the perspectives of the talent demand of the "job market of A-City" and the employment status of Chinese students, and predict and analyze the potential talent demand of A-City in the next three years to come.

(3) Try to infer the administrative category, possible geographical area, economic position, and hi-tech industry development of A-City using the data and conclusions from Question (2).

(4) Recent years, there have shown some new career preferences of college students, such as entering for village officer examinations, taking civil service examinations, starting their own businesses, picking up offsite jobs, and studying overseas. These preferences help diversify the career opportunities for college graduates. Try to model and quantify this phenomenon and provide strategies for the urban development and talent introduction for A-City.

(5) Write a letter to the school authorities about your suggestions and opinions regarding to the talent training program of a major you know well, covering the curriculum construction, the training of applicative talents, the individualization of college students, and the corresponding quality guarantee measures within the framework of your university and that major, according to the current market demand for talents.

2. Problem Analysis

For the problem one, the first step is to organize the data in Annex and classify and count 49 occupations. This question asks us to analyze the talent demand of "job market of A-City" from the three aspects of job demand, the desired profession, and the desired educational background，we can explore the relationship between the three indicators, judge their different influences on talent demand qualitatively and conduct modeling analysis from a quantitative perspective.

For the problem two, the question asks us to establish the actual talent demand model of A-City from the perspective of the talent demand of "job market of A-City" and the employment status of Chinese students. We can use Total demand of market jobs to reflect the employment situation of Chinese students, the more total jobs market supply, the better the employment situation of Chinese students. Therefore, we construct a linear programming mathematical model between total demand and total supply of market jobs, and then predict talent demand of A-City in the next three years through a time sequence model.

For the problem three, to judge the possible geographical area, economic position, and hi-tech industry development of A-City， we need to collect the data of some representative cities in China, such as Beijing, Shanghai, Wuhan, Chengdu, Xi'an, and Shenzhen, and then judge the possible geographical location and economic situation of a-city by matching occupational demand and supply situation.

For the problem four, to model and quantify the phenomenon of the career preferences for college students, we need to collect relevant data of college students' employment destination in recent years, and then analyze various employment destinations through comprehensive evaluation to get the preference of different employment destinations. Then, according to employment preference, we can provide relevant strategies for the development and talent introduction of A-City.

The problem five require us to write a letter to the school authorities about your suggestions and opinions regarding to the talent training program. So, this article aims at the accounting major of a 211 university， according to the current market demand for talent，analyze and propose corresponding suggestions from the curriculum construction, the training of applicative talents, the individualization of college students, and the corresponding quality guarantee measures.

3. Assumptions

To simplify the problems and make it convenient for us to simulate real-life conditions, we make the following basic assumptions, each of which is properly justified.

(1) Assuming that the data source is reliable and accurate.

(2) Assuming that the employment demand of A city is within the normal variable range.

(3) Assuming there is no economic crisis in the A market, social unrest.

(4) Assuming that abnormal data is ignored.

(5) Assuming that the population in city A does not change enormously with time.

4. Symbols and Definitions

Symbol	Definitions
Y	total supply of market jobs
X	total demand for market jobs
F_{t+T}	Predictive value of $t+T$
T	the first period to the forecast period of interval
a_t, b_t, c_t	parameters
F_t	three-exponential smoothing method predicted value
F_t'	expert modeler predicted value
n	month number of history data

5. Establishment and Solution of Model

5.1 The model of Problem 1

5.1.1 Preparations before Modeling

In order to facilitate the analysis, according to the national economic industry classification standard of the People's Republic of China, the data industries are divided into the following categories: Transportation industry、Manufacturing industry、Engineering industry、Construction industry、Technology industry、Education、Business management、Culture industry、Service industry、Financial industry、Others, the specific classification is shown in the figure below:

Table 1 Industry classification

Transportation industry	Logistics/warehousing、Transportation service

Manufacturing industry	Electronics/appliances/semiconductor/instrumentation、Biology/chemicals/pharmaceuticals/medical equipment、Fashion/textile/furs
Engineering industry	Engineering/machinery/energy
Construction industry	Construction/infrastructure/gardening、Real property
Technology industry	Computer software、Computer hardware、Internet development and application、IT-Management、IT-QM, technical support and more、Communications technology、Science & Technology、Technical work、Customer service and technical support
Education	Graduates、Education
Business management	Sales management
Culture industry	Art/graphics/Animation design、Restaurants & recreation、Literature/screenwriting/writing、Movies, TV and recreation、Advertising、PRs and news media
Service industry	Hospital/medical/care、Counsel/consulting、Translation、Security/housekeeping/other、Beauty and personal care、Hotels/tourism、Property management、Legal profession/law
Financial industry	Securities/finance/investment、Insurance、banking
Others	Other、QMS/safety/environmental protection

5.1.2 The establishment and solution of the model

(1) Qualitative analysis

1）Total employment and job demand

Based on the characteristics of the data given, the number of talents required every four months in each year is summarized and counts.

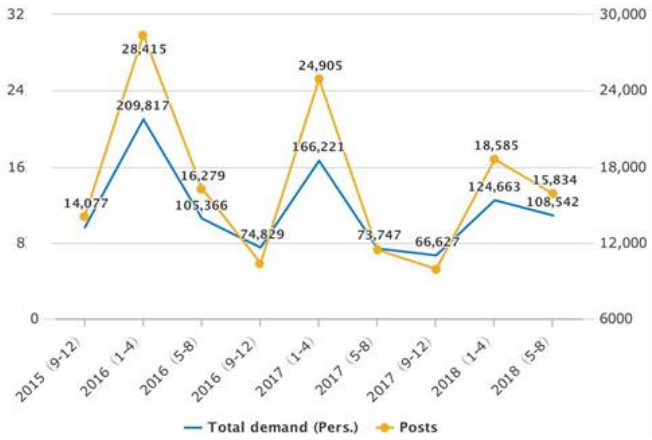


Figure 1 Post supply quantity in A city in recent years

As can be seen from the above figure, the number of monthly recruitment

positions has fluctuated in recent years. The first half of each year is the peak season for job recruitment demand and the demand for talents and the number of candidates reach the highest point. After that, the most prominent is from September to December, when the number of talent recruitment has dropped sharply, reflecting the cyclical characteristics. In addition, from the perspective of the main trend, the job demand of A-City is declining, and the number of employed people is also decreasing.

2）Total demands and posts of various sectors

This paper summarizes and divides the talent demand of each year. The following chart reflects the monthly demand in each year, as shown in the figure:

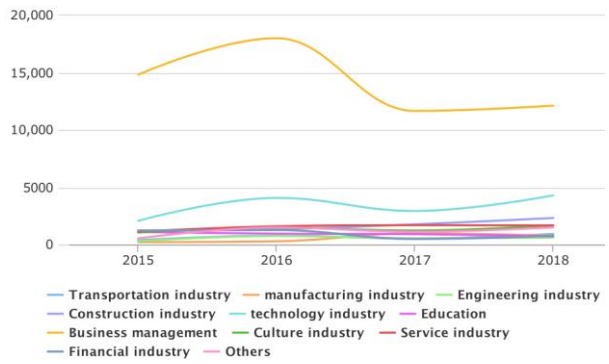


Figure 2 Total demands of various sectors sectors in recent years

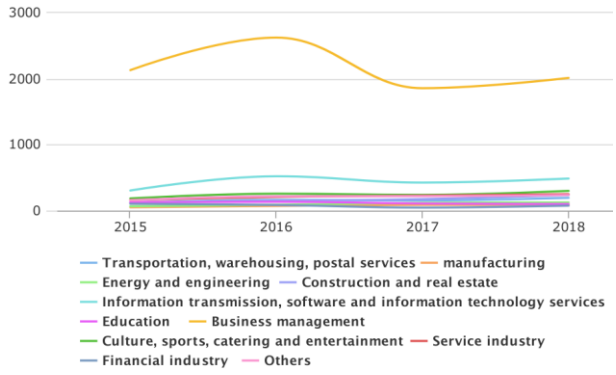


Figure 3 Posts of various in recent years

From the perspective of longitudinal analysis, as shown in the figure above, the trend of job demand and employment demand is basically the same, and the demand has reached a peak in 2016. Starting from 2016, the market demand of A-City has gradually declined and tends to be stable. In addition, as can be seen from the comparison of the two figures, there is a significant difference between job demand and employment demand, and job demand exceeds supply, indicating a severe employment situation.

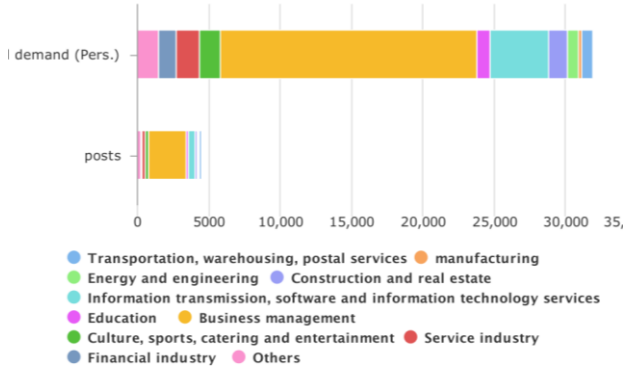


Figure 4 Total demands of various sectors in 2016

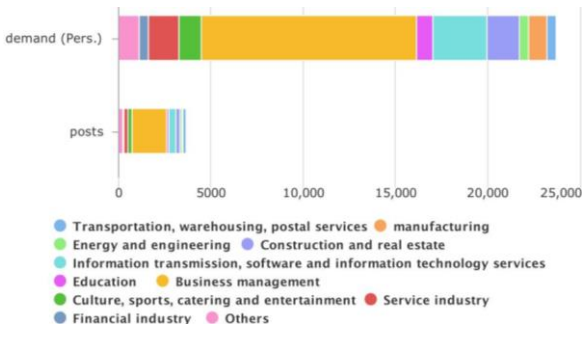


Figure 5 Posts of various sectors in 2017

From the point of transverse analysis, as shown in the 2016 and 2017 columnar

accumulation percentage in figure, the demand for management positions is significantly higher than that of other industries, accounted for nearly 50% of the total demand. Secondly, high-tech fields talent demand is also large, showing that A-City shows that A city is the main industrial pillar with high-tech, financial services and economic management.

3）Demand for talents of different academic qualifications

The summary and calculation of the academic qualifications were carried out, and the statistical analysis of the talent demand in each year was carried out from the following three aspects: undergraduate degree, undergraduate degree and bachelor degree.

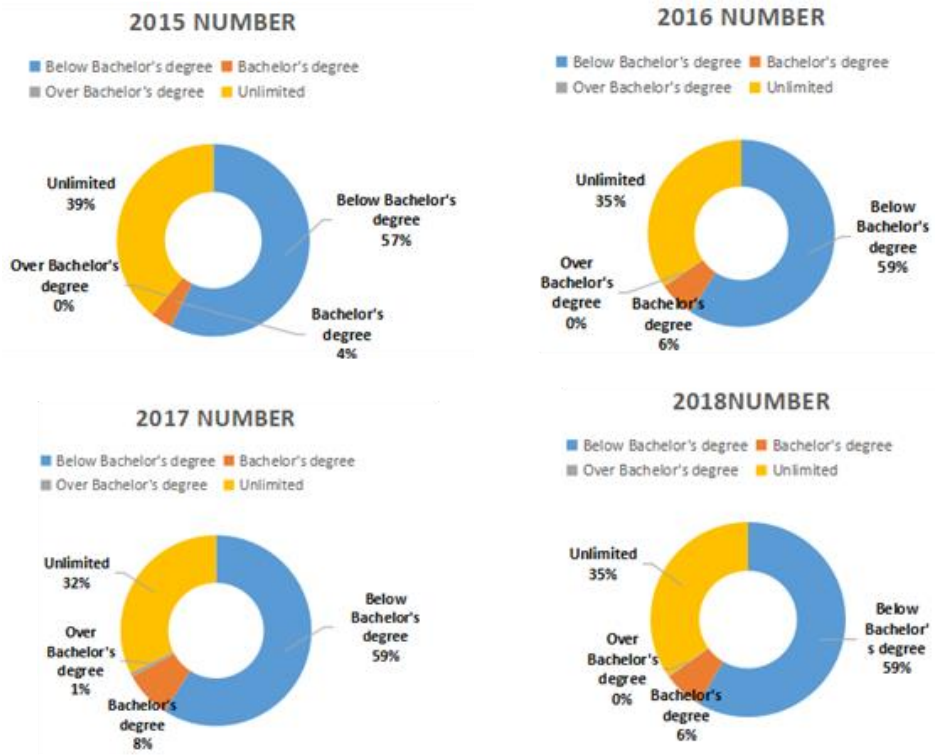


Figure 6 Educational background structure of talents

From the perspective of horizontal analysis, the demand for below bachelor's degree is close to 60%, and the total number of bachelor's degree and below bachelor's degree, unlimited is close to 99% of all demand. There are two main reasons. One is the shortage of high-level talents. For the requirements of academic qualifications, the requirements for high-tech talents are relatively low. Second, the demand for technical posts is far less than those with lower technical content and lower professional level. So that has caused this situation.

From the perspective of longitudinal analysis, the market has a certain improvement in the requirements of bachelor's degree and above bachelor's degree, indicating that the level of education in China has been improved, and the educational background requirements for talents have increased.

(2)、Quantitative analysis

1）Apriori algorithm correlation analysis

This paper uses modeling software and Apriori algorithm to analyze and explore the correlation between variables and indicators. The process is as follows:

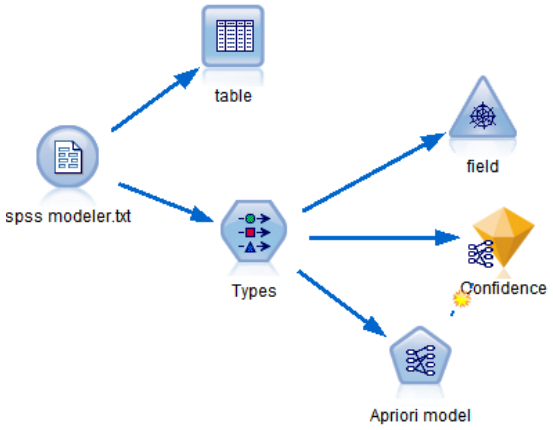


Figure 7 Apriori algorithm

Excluding the associations with less than 80% confidence, the results show that the following main association rules are:

Table 2 association rules

Sub-item Confidence	Previous item	Support degree	Confidence
posts = 1000-2000	Below bachelor's degree = 500-1000	27.273	100
	Below bachelor's degree = 500-1000 and Bachelor's degree = 300-600	18.182	100
	Below bachelor's degree = 500-1000 and Unlimited = below 500	27.273	100
	Bachelor's degree = 300-600 and Unlimited = below 500	18.182	100
	Below bachelor's degree = 500-1000 and Bachelor's degree = 300-600 and Unlimited = below 500	18.182	100
posts = 2000-3000	Unlimited = above 1000 and below Bachelor's degree = 1000-2000	18.182	100
	Unlimited = above 1000 and Bachelor's degree = below 300	18.182	100

	Unlimited = above 1000 and below Bachelor's degree = 1000-2000 and Bachelor's degree = below 300	18.182	100
	Below bachelor's degree = 1000-2000	45.455	80
	Below Bachelor's degree = 1000-2000 and Bachelor's degree = below 300	45.455	80
Total demand (Pers.) = 5000-10000	Unlimited = below 500 and above Bachelor's degree = below 20	18.182	100

Ⅰ. If the number of talents with below bachelor's degree is in the range of 500-1000, the number of jobs is in the range of 1000-2000.

Ⅱ. If the number of talents with below bachelor's degree is between 500 and 1000, and the number of talents with a bachelor's degree or less is between 300 and 600, then the number of jobs is between 1000 and 2000.

Ⅲ. .....

Ⅳ. If the number of talents with unlimited degree is less than 500 and the number of people with bachelor's degree (excluding bachelor's degree) is less than 20, the probability that the demand for jobs is between 5000 and 10000 is about 80%.

The relationship between variables and the above conclusions can be confirmed by the relational network diagram, as shown below. The thicker the line, the stronger the relationship variable.

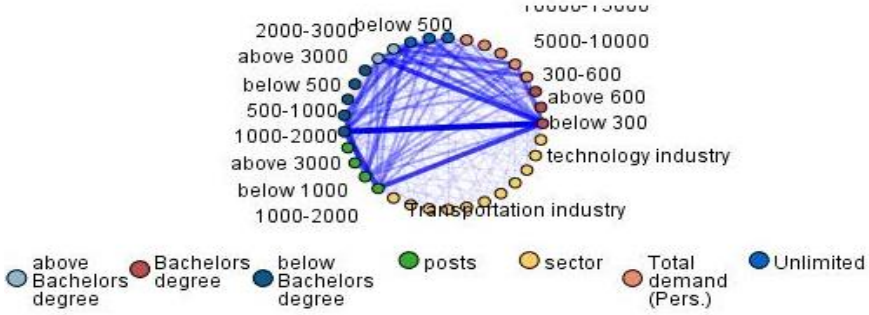


Figure 8 Relational network diagram

2)、Analysis of k-means and q-type clustering commonality

The result is as follows:

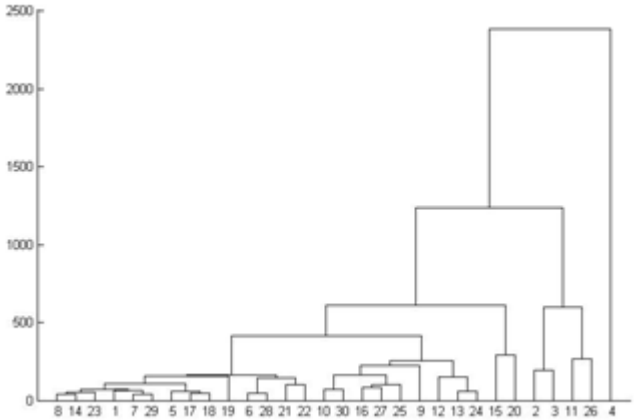


Figure 9 Histogram

Table 3 Grouping Condition

Group	Sector
1	Office administration/logistics、Internet development and application、Biology/chemicals/pharmaceuticals/medical equipment、Hospital/medical/care、Customer service and technical support、Electronics/appliances/semiconductor/instrumentation、、PRs and news media、Transportation service、Securities/finance/investment、Production/operation、QMS/safety/environmental protection、Technical work、Finance/auditing/tax、、Engineering/machinery/energy、HR、Senior management、Real property Restaurants & recreation Property management Trade、Hotels/tourism、Other、General merchandise/chains/retail、Science & Technology
2	Security/housekeeping/other
3	Sales management、market/marketing、Logistics/warehousing、Procurement
4	Sales
5	Computer software、Education、Translation、Construction/infrastructure/gardening、Graduates
6	Art/graphics/Animation design、Banking

Using the common clustering, and then carry on the descriptive statistical analysis.

Table 4 Mean

Number	below	Bachelor's degree	Above	Unlimited
1	317.54	30.54	.21	156.54
2	87.00	45.00	17.00	30.00
3	1379.25	138.75	.75	638.75
4	2189.00	53.00	.00	1753.00
5	72.60	49.00	3.40	33.80
6	359.00	189.00	4.50	122.50
sum	445.81	54.30	1.38	229.97

As can be seen from the above table, group 4 and group 3 have relatively loose requirements for academic qualifications, and there are a large number of people with unlimited qualifications. By Observing group 3, group 4 composition can be known, they are mainly in the category of sales logistics and have low technical content, so the result analysis is reasonable. Group 5 and group 6 have a relatively high proportion of bachelor's degree or above, mainly composed of art and technology,

with high professional knowledge requirements.

5.2 The model of Problem 2

5.2.1 The model of the actual talent demand of A-City

（1）The establishment of the model

We can use the total supply of market jobs and the total demand for market jobs to express the employment status of Chinese students and talent demand, so this question is transformed into researching the relationship between the total supply of market jobs and the total demand of market jobs. Through counting data in the Annex, we can obtain the annual talent demand and talent supply of "job market of A-City". Then we use SPSS to simulate and the established linear programming model is as follows:

$$Y = 231.463 + 0.138X \tag{1}$$

Among them，X is the total demand for market jobs，Y is the total supply of market jobs.

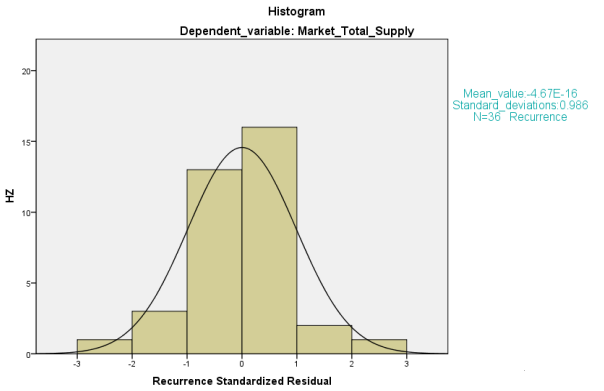


Figure 10 Histogram

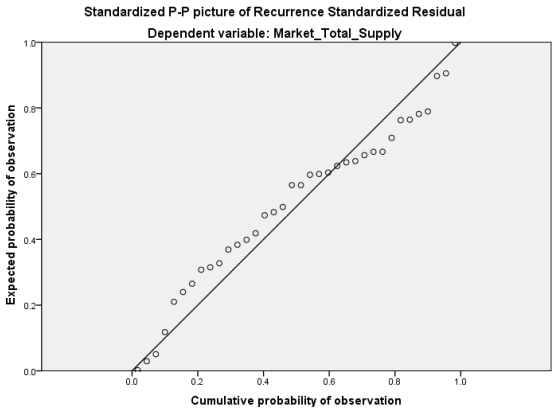


Figure 11 Fitting map

We can draw a graph of the total demand and the total supply of market jobs, as shown in the above picture.

（2）Model checking

In the figure below, the R-square of the third column is an important index for determining the goodness of linear equation fitting, which can explain the ability of regression model to vary dependent variables. It is generally believed that it needs to be more than 60%, and the closer to 100%, the better the fitting. It can be seen from the figure that the R-square result is 0.988, and the preliminary judgment model has a good fitting effect.

In the model residual independence test, we can get that DW is 1.794. By querying Durbin Watson table, it can be found that the value of this model happens to be in the range of values without autocorrelation, and it can be determined that the residual is independent, so it passes the test.

Table 5 Model test analysis

Model	R	R square	Adjust the R square	The error of the standard estimate	Durbin-Watson
1	.994a	.988	.987	356.949	1.794

As can be seen from the figure below, the significance value of anova $=0.000\prec 0.01\prec 0.05$, showing that the regression model of linear relationship established by independent variables and dependent variables has extremely significant statistical significance, that is to say, the total demand for market jobs has a significant linear relationship with the changes of market jobs supply.

Table 6 Anova

Model	Sum of square	df	Mean square	F	Sig.
Regression	3.437E8	1	3.437E8	2697.336	.000a
Residual	4332025.289	34	127412.509		
Total	3.480E8	35			

Judging whether the regression coefficient of the independent variable total market supply through the t test, t test for the null hypothesis regression coefficient is meaningless. By the last column available significance of regression coefficient values $=0.000\prec 0.01\prec 0.05$, indicating that the regression coefficient b exists, and has statistical significance, the total supply of market work and market work. There is a proportional relationship between aggregate demand, which is extremely distinctive.

Table 7 Coefficient

Model	Non-standardized coefficient		standard coefficient	t	Sig.
	B	Standard error			
constant	231.463	96.260		2.405	.022
Total demand for market jobs	.138	.003	.994	51.936	.000

5.2.2 Pridict and analyze talent demand for the next three years

（1）Three-dimensional exponential smoothing prediction

In order to predict the talent demand of A-City in the next three years, this paper constructs three exponential smoothing method modeling:

$$F_{t+T}=a_t+b_t\times T+c_t\times T^2 \tag{2}$$

In the formula, F_{t+T} is the Predictive value of $t+T$, T is the first period to the

forecast period of interval, a_t、b_t、c_t are parameters.

$$\begin{cases} S_t^{(1)} = a \times X_t + (1-a) \times S_{t-1}^{(1)} \\ S_t^{(2)} = a \times S_t^{(1)} + (1-a) \times S_{t-1}^{(2)} \\ S_t^{(3)} = a \times S_t^{(2)} + (1-a) \times S_{t-1}^{(3)} \end{cases} \tag{3}$$

$$\begin{cases} a_t = 3 \times S_t^{(1)} - 3 \times S_t^{(2)} + S_t^{(3)} \\ b_t = \dfrac{a}{2 \times (1-a)} \times (6 - 5 \times a) S_t^{(1)} - \left[2 \times (5-4a) S_t^{(2)} + (4-3a) S_t^{(3)} \right] \\ c_t = \dfrac{a^2}{2 \times (1-a)} \times \left(S_t^{(1)} - 2 \times S_t^{(2)} + S_t^{(3)} \right) \end{cases} \tag{4}$$

According to (2) and (3), the initial value $S_t^{(1)}$、$S_t^{(2)}$、$S_t^{(3)}$ and the smoothing coefficient a are the key factors determining the prediction accuracy of the model. Among them, the former can copy the value of the first period of the sequence or the average of the previous periods to $S_t^{(1)}$、$S_t^{(2)}$、$S_t^{(3)}$ according to the amount of the original market time series. The smoothing coefficient a can be determined by empirical judgment. The empirical judgment mainly depends on the development trend of the time series and the experience of the predictor, as is shown below:

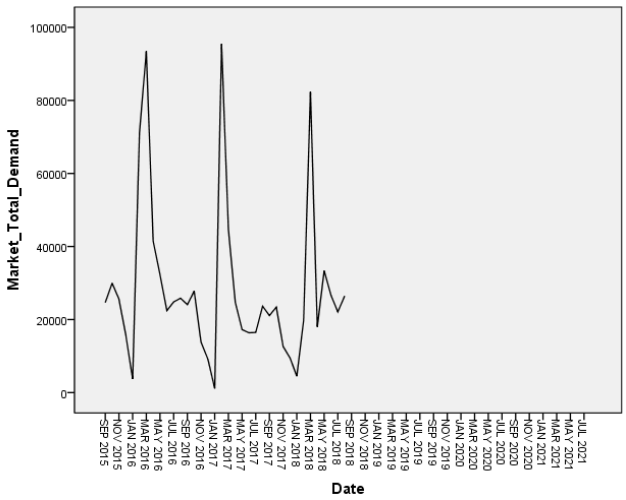
Ⅰ. The value range of a is at (0,1), and the value of a is generally (0,0.8).

Ⅱ. When the time series shows a relatively stable horizontal trend, a smaller value of a should be selected, and the value can be selected between 0.1 and 0.3 generally;

Ⅲ. when the time series fluctuates, but the long-term trend does not change much, you can choose a slightly larger value of a, often between 0.3 and 0.5;

Ⅳ. When the time series fluctuates greatly and the long-term trend changes greatly, showing a significant and rapid rise or fall trend, it is advisable to choose a larger a value, such as 0.6 to 0.8, so that the prediction model is more sensitive and can quickly keep up with the data changes.

We take $a = 0.6$ and $a = 0.8$ for prediction and compare and analyze the market demand and total supply map, and select the forecast with less prediction error.



Figures 12 The total demand of talents

Using MATLAB to predict the number of market demand in the next three years and using SPSS will simulate the forecast chart:

Ⅰ.When $a=0.6$ The forecast map of total demand of market jobs:

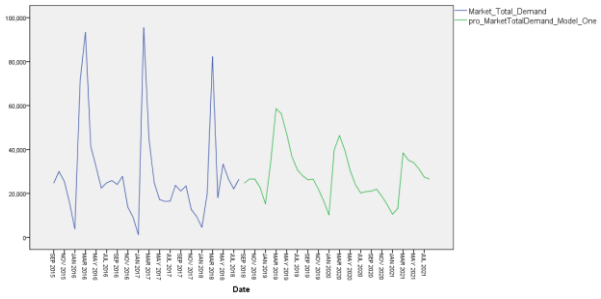


Figure 13 Total demand of market jobs

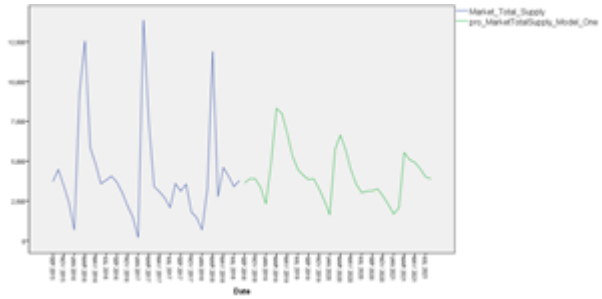


Figure 14 Total supply of market jobs

Using the model of total demand and total supply of market jobs to obtain the forecast map of total supply of market jobs:

Ⅱ.When $a=0.8$:

The forecast map of total demand of market jobs:

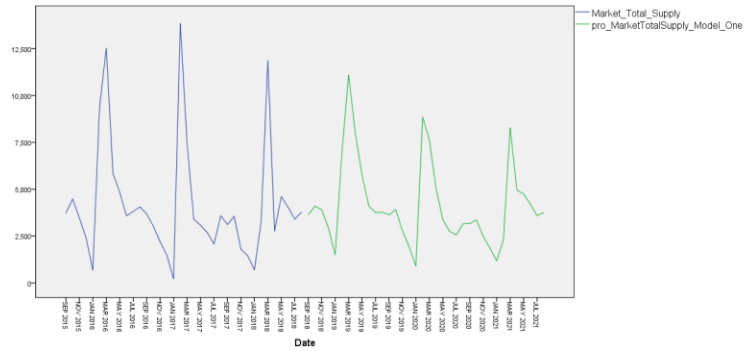


Figure 15 Total demand of market jobs

By comparison, the prediction effect is better when $a=0.8$.

It can be seen from the figure that the aggregate demand curve fluctuates

periodically, with a period of one year. The total demand is the lowest around January each year, and then the aggregate demand curve begins to rise sharply. It reaches the peak value around March and then falls sharply. The total demand showed a sawtooth fluctuation between April and September, followed by a sharp drop to the lowest point of total demand.

（2）Analysis of trends in each occupational demand and supply on a quarterly basis:

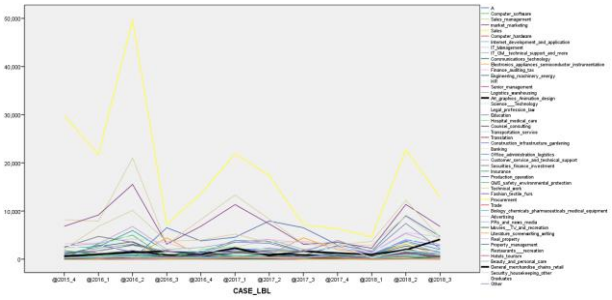


Figure 16 The demand map

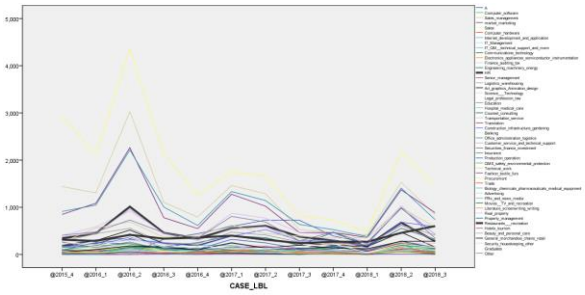


Figure 17 The supply map

By drawing the quarterly talent demand and supply maps of various industries, it is concluded that the talent demand and supply volume of various industries in the "job market of A-City" are unstable, and the hot industry is the sales, and the talent demand of the tertiary industry is rising and rising. Potentially hot industries will emerge in service industries such as catering or department store chain retail.

（3）Model checking

The stationary R square is 0.839, which is close to 1, indicating that the model fitting effect is good, and sig=0.094>0.05 is within the confidence interval and is qualified.

Table 8 Model statistic

Model	Number of predictors	Model fitting statistic	Ljing-Box Q(18)			Outlier value
		Smooth R square	Statistics	DF	Sig.	
Total demand for market jobs	0	.839	23.788	16	0.094	0

5.3 The model of Problem 3

The occupations in the Annex are divided into 11 categories, and the annual occupational category is counted separately:

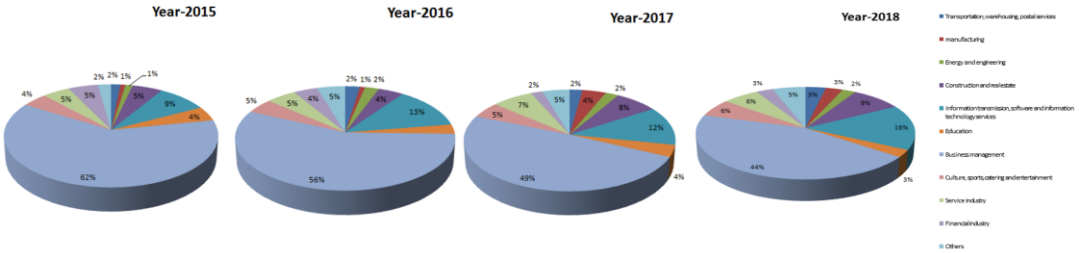


Figure 18 The demand map

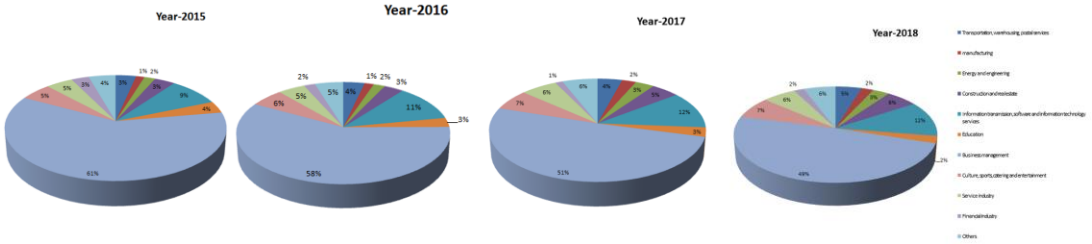


Figure 19 The supply map

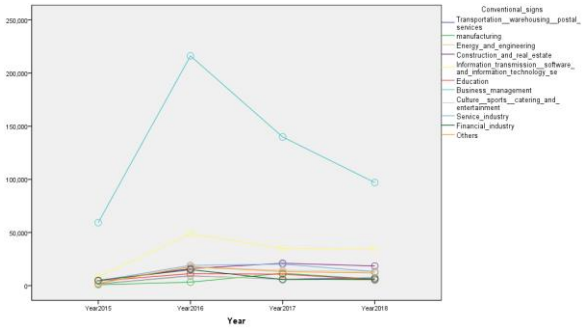


Figure 19 Demand trends in various industry categories

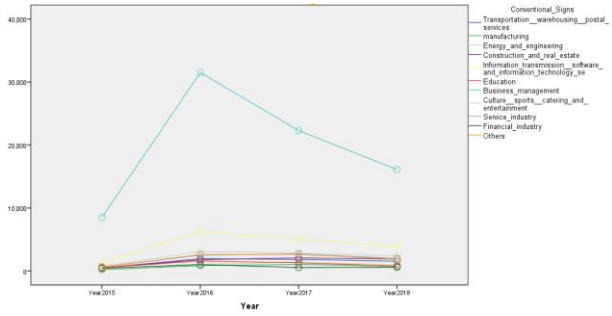


Figure 20 Supply trends in various industry categories

According to the quarterly statistics on the employment rate of "job market of A-City", as shown in the figure: the employment rate of "job market of A-City" is fluctuating around 15%.

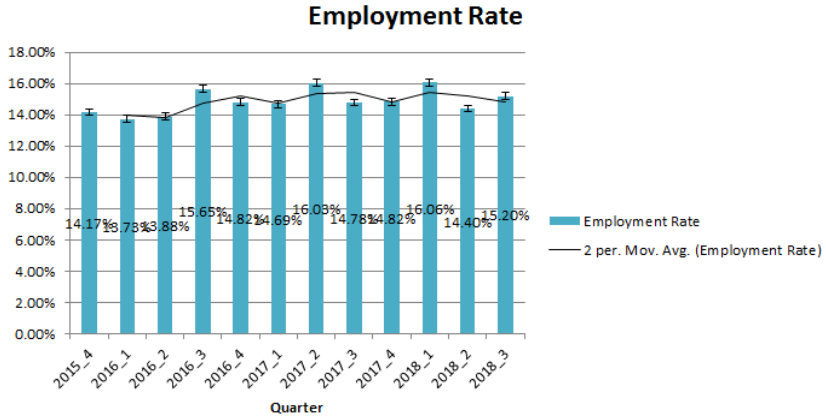


Figure 21 Employment rate

According to the occupation of the first, second and third industries in the Annex, the statistics table can be obtained:

Table 9 Tertiary industry situation

Group	Total demand (Pers.)				Total supply(Pers.)			
	2015	2016	2017	2018	2015	2016	2017	2018
Transportation, warehousing, p	1518	9238	6166	7323	478	1964	1838	1555
manufacturing	810	3291	11613	6123	198	852	1052	712
Energy and engineering	1177	8850	6443	4805	258	1058	1412	995
Construction and real estate	4898	15998	21064	18484	478	1794	2089	1887
Information transmission, soft	8265	48752	35068	34269	1221	6248	5097	3891
Education	4331	11295	10775	5688	506	1594	1295	789
Business management	59332	216190	139928	96992	8523	31497	22287	16104
Culture, sports, catering and	4160	17450	14572	13341	741	3085	2865	2394
Service industry	4499	19050	20182	13283	634	2501	2724	1990
Financial industry	4832	15019	5715	5958	411	1025	550	601
Others	2124	17784	13266	11882	629	2611	2628	1896
sum	95946	382917	284792	218148	14077	54229	43837	32814
Third_Industry_ratio	91.84%	90.32%	83.87%	83.27%	90.73%	90.31%	86.84%	86.30%

In the table, the orange shading is not in the tertiary industry, the red shading is the percentage of demand and supply in the tertiary industry, and the percentage of demand and supply in the tertiary industry of "job market of A-City" is about 90% of the percentage in the past three years.

By counting the employment rate of A and the demand and supply of the tertiary industry in the A market, it can be concluded that the administrative type of A-city is the positive ministerial level; the Chinese ministry is known: Beijing, Shanghai, Tianjin, Chongqing; By looking up information, Beijing, Shanghai's employment rate in the past three years is about 15%, Shanghai, Beijing's tertiary industry demand supply is more than 80%, then A-City may be Beijing or Shanghai. Geographical area is in the coastal area, through the above picture found the demand and supply of the tertiary industry in A-City is large, and the economy of the tertiary industry is an important contribution to the GDP of the city and the country, so, A-City has a high economic status.

5.4 The model of Problem 4

5.4.1 Preparations before Modeling

With the development of economy and the diversification of industry, college students are faced with a severe employment situation, at the same time, employment prospects and opportunities have been expanded. A variety of paths enable more college students to get the opportunity of "all roads lead to Rome". According to the survey data of about 160,000 college graduates conducted by education economic research institute of Peking University, we conducted a series of analysis and research. The percentage of Chinese college graduates going from 2007 to 2017 is shown as follows:

Table 10 Employment condition in recent years

Employment condition	Years							
	2003	2005	2007	2009	2011	2013	2015	2017
Determined authority	40.7	47.2	40.4	34.5	43.3	43.5	33.3	38.8
Further education(domestic)	15.1	16.8	14.1	18.3	13.7	14	18.6	20.4
Going abroad / leaving the country		2.3	2.7	3.2	2.6	2.8	5.8	5.9

Freelance	4	3.6	4.1	3.3	4.3	2.6	4.7	5
Self-employment			3.2	2.4	3.2	2.1	4.6	4.7
Other flexible employment			6.6	5.4	5.1	7	16.1	9.7
Waiting for employment	35.8	22.4	22.6	26.4	21.9	23.4	12.8	10.1
Not working and going to school	1.7	4.8	2.9	3.1	2.4	2	2.2	3
Other temporarily not employed			2.4	2.2	2.1	1.8	1.3	1.4
other	2.7	3	1.1	1.2	1.5	0.9	0.7	0.9

Analysis of college students' behavior on campus and prediction of graduation destination:

Table 11 Employment distribution by nature of work unit

	2003	2005	2007	2009	2011	2013	2015	2017
Party and government organs	12.4	9.2	12.7	10.0	4.8	5.8	5.6	5.6
Schools	23.1	19.3	5.4	6.0	7.5	2.6	8.3	6.5
Scientific research departments	4.1	4.7	1.1	1.7	1.0	1.6	1.6	1.3
State-owned enterprises	34.5	29.7	23.5	34.5	23.1	30.2	28.0	23.5
The private enterprise	10.7	16.3	34.2	31.0	45.8	38.2	36.7	40.7
Joint ventures	8.3	9.5	9.5	6.8	7.2	7.6	8.9	7.5
Others	6.9	11.3	13.4	9.2	10.6	11.9	11.0	14.9

5.4.2 The establishment and solution of the model

(1) Employment trend and proportion analysis

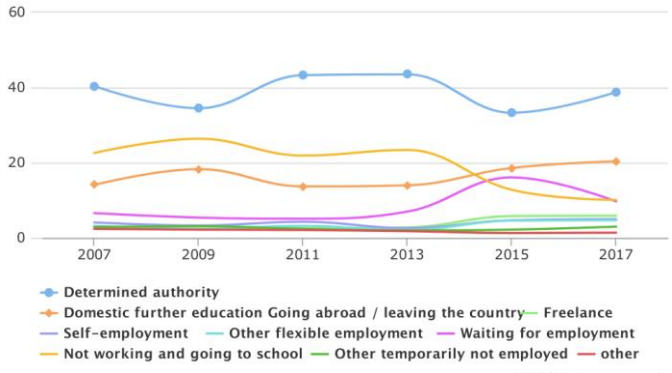


Figure 22 Employment condition in recent years

As is shown in the figure above, the number of people who choose to go to enterprises and institutions accounts for the largest proportion, fluctuating up and down around 40%. Secondly, going abroad and studying in China (for postgraduate

study) become the main choices for college graduates, with the proportion fluctuating around 20%. It can be noted that since 2015, the number of students going abroad has exceeded the number of students going to college in China, which indicates that with the deepening of the country's openness and the improvement of national economic strength, more and more students are willing to go overseas to study and pursue advanced studies to enhance their own strength and increase their future employment capital. In addition, the number of other temporary unemployed has increased significantly in 2013-2015.

(2) Employment choice evaluation model

1) Employment aspirations

According to the above survey data, the popularity of graduates' employment destination was evaluated and analyzed. In this paper, we use MATLB to perform AHP

Ⅰ. Hierarchical model

First of all, according to the survey and research, the employment factors of graduates are divided into the following aspects: freedom of work, stability of work, high economic income, easy access to power and resources, comfortable and relaxed, good prospects for development, whether they can display their talents and interests. According to the above factors, we established the following hierarchical structure model. As shown in the figure

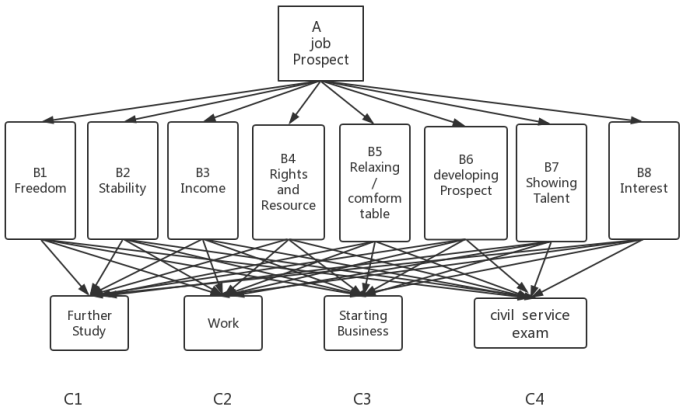


Fig. 23 Hierarchical structure model

Ⅱ. Establish judgment matrix

By consulting the literature, we get expert scoring and career intentions, and compare the various levels and factors to form a judgment matrix. The matrix element assignment is defined as follows:

Table 12 Matrix element assignment list

Score	Implication
1	Equal importance to two elements

3	Compared with the two elements, the former is slightly more important than the latter.
5	Compared with the two elements, the former is obviously more important than the latter.
7	Compared with the two elements, the former is more important than the latter.
9	Compared with the two elements, the former is more important than the latter.
2、4、6、8	Intermediate value of the above adjacent judgment
Reciprocal	If the ratio of the importance of the factors i to j is a_{ij}, then the importance of the factors j and i is $a_{ji} = \frac{1}{a_{ij}}$.

By consulting the data, we get the score of the experts. The judgment matrix of the criterion layer is:

Table 13

A	B1	B2	B3	B4	B5	B6	B7	B8
B1	1	2	6	1/5	1/4	7	5	4
B2	1/2	1	3	1/6	1/7	6	5	2
B3	1/6	1/3	1	1/5	1/6	5	3	1/2
B4	5	6	5	1	1/2	9	7	5
B5	4	7	6	2	1	9	8	5
B6	1/7	1/6	1/5	1/9	1/9	1	1/2	1/5
B7	1/5	1/5	1/3	1/7	1/8	2	1	1/3
B8	1/4	1/2	2	1/5	1/5	5	3	1

According to the above method, we also establish a judgment matrix for the solution layer. See the appendix for details.

Ⅲ. Hierarchical sorting and consistency checking

a）Using the sum-product method to find the largest eigenvalue $\lambda_{\max}$ and the eigenvector ω of the comparison matrix.

Among them, $\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(M\omega)_i}{\omega_i}$

b）Consistency check

Calculate the CI : $CI = \frac{\lambda_{\max} - n}{n-1} i$

We can determine RI by looking up the table，as shown in the table：

Table 14 Average random consistency index

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.31	1.41	1.45

So, CR=CI/RI，then performing a total hierarchical sorting

c）By MATLB calculation, the total hierarchical sorting result is:

The weight of the criterion layer is:

$$[0.0846 \quad 0.0386 \quad 0.1251 \quad 0.0890 \quad 0.0653 \quad 0.3126 \quad 0.1712 \quad 0.0398]$$

The total sorting weight is：

$$[0.2805 \quad 0.1527 \quad 0.1921 \quad 0.3748]$$

It can be seen that, regardless of family economic strength, academic performance and other factors to analyze the employment intention of graduates, most graduates are more willing to take the public examination and continue to further study for seeking stable development and deeper strength improvement.

2）Analysis of employability factors

Ⅰ.Grey relevancy analysis

Grey relevancy analysis can find the degree of correlation of various factors or variables in incomplete information, and then find the main contradiction. On the basis of operability and scientificity, the index system is constructed from five perspectives: educational background, personal capital, family factors, social factors and individual wishes and expectations. By consulting the literature and collecting data, we analyze the following indicators: school strength, Professional discipline, academic performance, comprehensive quality, professional certificate, family economy, supply and demand of talent market, desire for further study, region, treatment, etc.

Table 15

The evaluation index	x1	x2	x3	x4	x5	x6	x7	x8
The school strength r1	3.71	3.6	3	2.83	3.17	3.5	3.57	2.83
Academic performance r2	2	3.1	2.57	2.83	3	2.5	3.14	3.17
The comprehensive quality r3	4.86	4.2	4.3	4.5	4.17	4	3.57	5
Professional certificate r4	3.29	3.9	4	4.17	2.83	3	4.14	3.67
Family economic r5	2.57	3.6	3.43	2.83	3.33	3.5	2.71	3
Social relationsr6	4.86	3.8	4.14	4.17	3.17	4	3.57	3.83
Treatment r7	3.71	4.3	4.43	4.17	4	4	4.29	4.5

The supply and demand of the talent market r8	4.43	3.9	4.14	4	3.17	3	3.58	3.83
Desire for further study r9	3	2.9	2.86	3.17	3.17	3	3.43	2.5
Professional discipline r10	3.43	3.7	3.86	3.83	3.5	4.5	3.29	4.17
Region r11	3.29	3.2	3.57	3.67	3.17	3.5	3.29	3.83

The calculation method of grey relevancy coefficient is as follows:

$$\frac{\min\limits_{i}\min\limits_{k}\left|x_0(k)-x_i(k)\right|+\rho\max\limits_{i}\max\limits_{k}\left|x_0(k)-x_i(k)\right|}{\left|x_0(k)-x_i(k)\right|\rho\max\limits_{i}\max\limits_{k}\left|x_0(k)-x_i(k)\right|} \tag{5}$$

Among them, ρ is the resolution ratio. The bigger the resolution ratio, the bigger the resolution. On this basis, calculate the correlation coefficient:

$$r_i=\sum_{k=1}^{n}\omega_i\xi_i(k) \tag{6}$$

The assignment for this article is as follows: $\rho=0.5$, $\omega_i=\frac{1}{n}$,

The results are as follows:

The coefficient matrix is:

$$\begin{bmatrix}
1 & 0.8 & 0.3826 & 0.3333 & 0.449 & 0.6769 & 0.7586 & 0.3333 \\
0.3333 & 0.8931 & 0.4937 & 0.6324 & 0.7748 & 0.4661 & 0.9521 & 1 \\
0.8363 & 0.4719 & 0.5053 & 0.5885 & 0.4628 & 0.4169 & 0.3333 & 1 \\
0.4323 & 0.7128 & 0.7976 & 1 & 0.3333 & 0.3641 & 0.9571 & 0.5726 \\
0.3333 & 1 & 0.7518 & 0.4008 & 0.6561 & 0.8374 & 0.3665 & 0.4619 \\
1 & 0.4436 & 0.5399 & 0.5505 & 0.3333 & 0.4956 & 0.3958 & 0.4507 \\
0.3333 & 0.6639 & 0.8495 & 0.5448 & 0.4413 & 0.4413 & 0.6529 & 1 \\
0.3333 & 0.4427 & 0.3854 & 0.4169 & 0.8079 & 1 & 0.5521 & 0.4628 \\
0.4819 & 0.5376 & 0.5636 & 0.4097 & 0.4097 & 0.4819 & 0.3333 & 1 \\
0.8121 & 0.5961 & 0.5149 & 0.5284 & 0.7423 & 0.3333 & 1 & 0.4074 \\
0.7333 & 0.9167 & 0.4521 & 0.3976 & 1 & 0.5 & 0.7333 & 0.3333
\end{bmatrix}$$

The result of correlation degrees is as follows:

$$\begin{bmatrix}0.5269 & 0.5581 & 0.6622 & 0.6316 & 0.5608 & 0.6361 & 0.5941 & 0.6354 & 0.5474 & 0.5064 & 0.5139\end{bmatrix}$$

The list is as follows:

Table 16

	The school strength r1	Academic performance r2	The comprehensive quality r3	Professional certificate r4	Family economic r5	Social relationsr6

Correlation	0.5269	0.5581	0.6622	0.6316	0.5608	0.6361
Ranking	9	7	1	4	6	2
	Treatment r7	The supply and demand of the talent market r8	Desire for further study r9	Professional disciplines r10	Region r11	
Correlation	0.5941	0.6354	0.5474	0.5064	0.5139	
Ranking	5	3	8	11	10	

Ⅱ. Principal component analysis

The main steps are as follows:

a) After standardizing the data, we can find the correlation coefficient matrix and calculate their eigenvalues and eigenvectors. The principal component variable consisting of the eigenvectors is:

$$\begin{aligned} y_1 &= u_{11}\tilde{x}_1 + u_{21}\tilde{x}_2 + \ldots + u_{p1}\tilde{x}_i \\ y_2 &= u_{12}\tilde{x}_1 + u_{22}\tilde{x}_2 + \ldots + u_{p1}\tilde{x}_i \\ &\vdots \\ y_p &= u_{1p}\tilde{x}_1 + u_{2p}\tilde{x}_2 + \ldots + u_{pp}\tilde{x}_p \end{aligned} \tag{7}$$

b) Select p principal components to calculate the information contribution rate b_j and cumulative contribution rate of eigenvalues α_p,

$$b_j = \frac{\lambda_j}{\sum_{k=1}^{5}\lambda_k}, \qquad \alpha_p = \frac{\sum_{k=1}^{p}\lambda_j}{\sum_{k=1}^{5}\lambda_k} \tag{8}$$

c) Calculate the composite score

$$Z = \sum_{j=1}^{p} b_j y_j \tag{9}$$

The results obtained are as follows:

Table 17 Result

	The school strength r1	Academic performance r2	The comprehensive quality r3	Professional certificate r4	Family economic r5	Social relationsr6
value	-0.9802	-2.3225	2.4957	-0.0291	-1.0639	0.8821
ranking	8	11	1	6	9	3
	Treatment r7	The supply and demand of the	Desire for further study r9	Professional disciplines	Region r11	

		talent market r8		r10	
value	2.1318	0.3636	-1.8525	0.8423	-0.4672
ranking	2	5	10	4	7

From the comparison of the results of the two methods, the influence degree of various factors is roughly same. Among the factors of employment, the most important factor is the comprehensive quality ability of graduates, Therefore, personal improvement of talents is very important, and this is the reason why today's most excellent graduates chose to go abroad or stay in domestic for further studies. Secondly, social relations and professional certificates, as well as trends and circumstances in the general environment also play important roles in the whereabouts of graduates.

5.4.3 The strategies for the urban development and talent introduction

Based on above conclusions, following measures are put forwarded:

First of all, optimize innovation policy environment of company and encourage college student start their own business. To attract talent, government can provide venture supporting policies like secured loan application.

Secondly, introduce pillar industry talents and improve welfare treatment, provides opportunities and environment for talents at home and abroad, showing t fairness and great treatment

At last, we can establish internship bases for college graduates, encourage them to stay in local areas to find jobs after graduation, provide guidance and training for graduation work.

5.5 A letter about the talent training program

Dear officer,

With rapid developments of social economy, the talents demand is constantly increasing and expanding. How to cultivate high-quality talents is a realistic problem. Therefore, reasonable talent training strategies should be formulated and improved. In term of accounting major, suggestions and opinions are as follow:

Firstly, for construction of accounting courses, university should reasonably allocate the proportion of compulsory and elective courses to promote the enthusiasm of students as far as possible. Solid theoretical knowledge can provide good capital for practice and ensure that the courses meet learning and social development needs.

Secondly, the cultivation of applied talents must not only have a solid theoretical knowledge base, but also improve practical ability. The school provides accounting experiment courses, social practice and practical training courses to enhance the application level of students' accounting skills, strengthen practical teaching, cultivate the practical application ability and innovative spirit of accounting majors, achieving the training objectives of applied accounting talents.

Thirdly, the tutor system can be implemented to realize the individualization of college students. Students choose their personality development goals according to their actual situation, guiding them to develop practical implementation plans based on respecting the choice of students' courses. Students choose professional courses

under the guidance of interest. It helps teachers to provide comprehensive guidance for students . Great significance for innovative ideas and reasonable career planning can be shown.

Finally, in terms of improving the quality of teaching, it is highly valued in colleges and universities, providing students with corresponding guarantees for market talent recruitment:

(1) Improve the talent development plan

When formulating a talent training plan, it should be implemented in accordance with the principle of "basic foundation, large caliber, strong ability and high quality". The comprehensive talent training program mainly includes ideological and moral cultivation, scientific research innovation, social practice, organizational management and cultural accomplishment. Emphasize that students must not only have high professional skills, but also have a high overall quality and develop students' all-round development ability.

(2) Guarantee the quality of teachers

Colleges and universities should adhere to the principle of combining training with the introduction of teachers, focus on improving the teaching and research level of existing teachers, improve the academic structure of the team, strengthen the training of young teachers, and formulate incentives.

(3) Adhere to mechanism and system construction

Establish a complete information feedback mechanism and quality monitoring system. Adopting a two-way monitoring mode, quality of teaching should be monitored with the participation of students and teachers

We hope our work is helpful to you!

Yours,
Team 80284

6. Model adaptability test

Using SPSS for three exponential smoothing models to test.

Table 17 Model statistic

Model	Number of predictors	Model fitting statistic	Ljung-Box Q(18)			Outlier value
		Smooth R square	Statistics	DF	Sig.	
Market_Total_Demand-Model_1	0	.840	24.009	16	.089	0

From the model fitting table, the R square and the stationary R square can be known. The R fit and the stationary R square can be used to evaluate the simulation fit,

and when comparing multiple models, the optimal model can be found by comparing the statistics. Since the original variables have seasonal variation factors, the stationary R square has more reference significance, equal to 84%, and the fitting effect is better.

Through the data in the model statistic, the significance of the Ljung-Box Q(18) statistic is P=0.089, which is greater than P=0.05. Within 95% of the confidence interval, the residual of this sequence is consistent with the random distribution, and there is no outlier. The appearance of the value, through these data to illustrate the model's fitting effect is better.

7. The Evaluation of Model

7.1 Strength

(1) Simple calculation and practical application. The cubic exponential smoothing prediction method is an important method of time series analysis. It enhances the influence of recent data on the predicted value by the weighted coefficient. The calculation is simple and easy to operate.
(2) Optimization is simple, when using the adaptive traversal method to track the smoothing coefficient, it can greatly improve its prediction accuracy.
(3) Strong compatibility, easy to combine prediction with multiple methods
(4) Stability, exponential smoothing is a method that can be applied to various future data predictions. Many predictors use this method for analysis and prediction.
(5) Comparison and Analogy. We build the model on the basis of various perspectives, such as qualitative analysis and quantitative analysis, global analysis and partial analysis, indicating the scientific and rational feature.
(6) The exponential smoothing method requires less data. In this problem, it is feasible to use the model.

7.2 Weakness

(1) The article is only based on the perspectives of time efficiency analysis
(2) The time series prediction model works well because it is difficult to obtain sufficient data.

8. Extension of Model

Figure 24 Flow chart

The three-time smoothing exponential model gradually decreases with the passage of time. The value predicted in the rising phase tends to be lower than the true value. In the falling phase, the predicted value is higher than the true value, that is to say, it shows obvious hysteresis. This hysteresis is because the exponential smoothing method often uses historical data values for weighting processing, and the obtained data values are ignored. Combined with the SPSS expert modeler, considering the influence of seasonal factors, we predict the number of future talent demand for the A-City. The three-exponential smoothing method predicted value F_t and the SPSS expert modeler predicted value $F_t^{'}$ are averaged as the predicted value, and then the A-market future occupational supply forecast can be obtained.

Use $e_{MAPE}=\frac{1}{n}\times\sum_{1}^{n}\left|\frac{F_t-F_t^{'}}{F_t}\right|\times100\%$, $e_{RMSE}=\sqrt{\frac{1}{n}\sum_{1}^{n}\left(F_t-F_t^{'}\right)^2}\times100\%$ to check if the model is improved, as shown below:

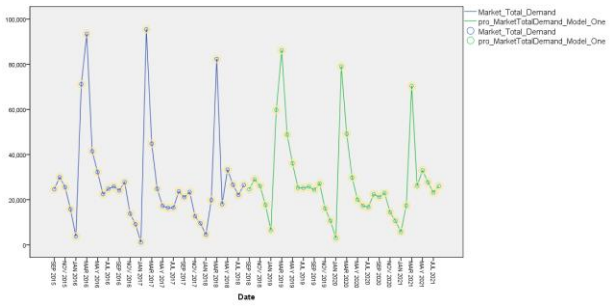


Figure 25 Optimization map

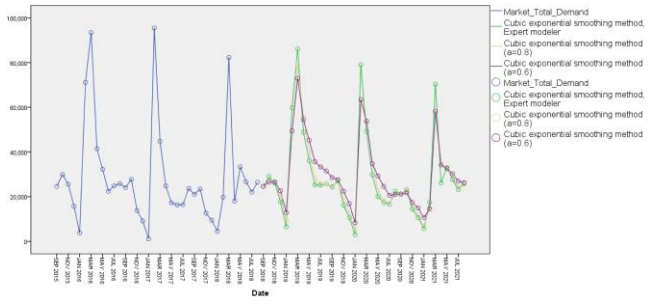


Figure 26 Comparison chart

Table 18 Checklist

Model	e_MAPE/%	e_MSE/PERS
Cubic exponential smoothing method(a=0.8)	31%	9614

Cubic exponential smoothing method(a=0.6)	57%	10922
Cubic exponential smoothing method , Expert modeler	15%	4807

It can be seen from the table that the improved indicators are better than the other two methods. Among them, in the prediction accuracy, the average relative error of the improved model is 15%, which is much lower than 31% and 57% of the traditional exponential smoothing method. It also shows that the coefficient a has a great influence on the prediction effect of the exponential smoothing method.

9. Suggestions

(1) The exponential smoothing smoothing coefficient a is a reflection of the predictive model's ability to change the speed and smoothness of the data. The choice of the value of α directly determines the accuracy of the prediction result. When using this model, the adaptive traversal method should be used to track the smoothing coefficient and improve its prediction accuracy.
(2) Using this model, the expert modeler or regression prediction should be used together to reduce the prediction error and obtain more accurate prediction results.
(3) The model is suitable for short- and medium-term predictions, and has large errors for long-term predictions.

10. References

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11. Appendix

Appendix 1: K-Means Clusting /SPSS

```
QUICK CLUSTER Zbelow ZBachelorsdegree Zover ZUnlimited
  /MISSING=LISTWISE
  /CRITERIA=CLUSTER(6) MXITER(100) CONVERGE(0)
  /METHOD=KMEANS(NOUPDATE)
  /SAVE CLUSTER
  /PRINT ID(sector) INITIAL.
/MEANS TABLES=below Bachelorsdegree over Unlimited BY QCL_3
  /CELLS MEAN.
```

Appendix 2: Final clustering center

	Clustering					
	1	2	3	4	5	6
Zscore(below)	-.25691	-.71867	1.86960	3.49147	-.74751	-.17388
Zscore: Bachelor's degree	-.44734	-.17508	1.59032	-.02443	-.09975	2.53658
Zscore(over)	-.37067	4.94892	-.19907	-.43667	.64045	.98893
Zscore(Unlimited)	-.21470	-.58470	1.19522	4.45316	-.57359	-.31424

Appendix 3: Number of cases in each cluster

Clustering	1	2.000
	2	4.000
	3	1.000
	4	1.000
	5	29.000
effective		37.000
Missing		.000

Appendix 3: Q-type clustering /MATLAB

```
clc,clear
load g.txt     % Save the original data in plain text file gj.txt
gj=zscore(g); % Data standardization
y=pdist(g); % Find the Euclidean distance between objects, each line is an object
z=linkage(y,'average');    % Cluster by class average method
h=dendrogram(z);    % Draw clustering diagram
set(h,'Color','k','LineWidth',1.3)
% Change the color of the clustering line to black, and the line width is bold
for k=3:5
    fprintf(' The results of dividing into %d are as follows： \n',k)
    T=cluster(z,'maxclust',k);    % Divide sample points into k
    for i=1:k
      tm=find(T==i);    % Find the object of the i-th class
      tm=reshape(tm,1,length(tm)); % Become a row vector
      fprintf(' The first %d class has %s\n',i,int2str(tm)); % Display classification results
    end
    if k==6
        break
    end
    fprintf('**********************************\n');
end
```

Appendix 4: Case processing summary

	Case					
	Included		Excluded		total	
	N	percentage	N	percentage	N	percentage
below * Case number of the case	37	100.0%	0	.0%	37	100.0%
Bachelor's degree * Case number of the case	37	100.0%	0	.0%	37	100.0%
over * Case number of the case	37	100.0%	0	.0%	37	100.0%
Unlimited * Case number of the case	37	100.0%	0	.0%	37	100.0%

Appendix 5: Apriori_ algorithm table

Sub-item Confidence	Previous item	Support degree	Confidence
posts = 1000-2000	below Bachelors degree = 500-1000	27.273	100
posts = 1000-2000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600	18.182	100
posts = 1000-2000	below Bachelors degree = 500-1000 and Unlimited = below 500	27.273	100
posts = 1000-2000	Bachelors degree = 300-600 and Unlimited = below 500	18.182	100
Total demand (Pers.) = 5000-10000	Unlimited = below 500 and above Bachelors degree = below 20	18.182	100
posts = 2000-3000	Unlimited = above 1000 and below Bachelors degree = 1000-2000	18.182	100
posts = 2000-3000	Unlimited = above 1000 and Bachelors degree = below 300	18.182	100
posts = 1000-2000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600 and Unlimited = below 500	18.182	100
posts = 2000-3000	Unlimited = above 1000 and below Bachelors degree = 1000-2000 and Bachelors degree = below 300	18.182	100
posts = 2000-3000	below Bachelors degree = 1000-2000	45.455	80
posts = 2000-3000	below Bachelors degree = 1000-2000 and Bachelors degree = below 300	45.455	80
posts = 1000-2000	Unlimited = below 500	36.364	75
Total demand (Pers.) = 10000-15000	below Bachelors degree = 500-1000	27.273	66.667
posts = 1000-2000	Bachelors degree = 300-600	27.273	66.667
posts = 2000-3000	Unlimited = 500-1000	27.273	66.667
Total demand (Pers.) = 10000-15000	below Bachelors degree = 500-1000 and Unlimited = below 500	27.273	66.667

posts = 2000-3000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000	27.273	66.667
posts = 2000-3000	Unlimited = 500-1000 and Bachelors degree = below 300	27.273	66.667
posts = 2000-3000	below Bachelors degree = 1000-2000 and above Bachelors degree = below 20	27.273	66.667
posts = 2000-3000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and Bachelors degree = below 300	27.273	66.667
posts = 2000-3000	below Bachelors degree = 1000-2000 and above Bachelors degree = below 20 and Bachelors degree = below 300	27.273	66.667
posts = 2000-3000	Bachelors degree = below 300	63.636	57.143
posts = above 3000	Unlimited = above 1000	36.364	50
Total demand (Pers.) = 5000-10000	Unlimited = below 500	36.364	50
Total demand (Pers.) = 5000-10000	above Bachelors degree = below 20	54.545	50
Total demand (Pers.) = 10000-15000	Unlimited = below 500	36.364	50
posts = 2000-3000	Unlimited = above 1000	36.364	50
Total demand (Pers.) = 100000-150000	Unlimited = above 1000 and above Bachelors degree = below 20	18.182	50
posts = below 1000	Unlimited = below 500 and above Bachelors degree = below 20	18.182	50
posts = below 1000	Unlimited = below 500 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 20000-25000	Unlimited = 500-1000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 20000-25000	Unlimited = above 1000 and below Bachelors degree = 1000-2000	18.182	50
Total demand (Pers.) =	Unlimited = above 1000 and Bachelors degree = below 300	18.182	50

20000-25000			
posts = above 3000	Unlimited = above 1000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 5000-10000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600	18.182	50
Total demand (Pers.) = 10000-15000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600	18.182	50
Total demand (Pers.) = 5000-10000	Bachelors degree = 300-600 and Unlimited = below 500	18.182	50
Total demand (Pers.) = 10000-15000	Bachelors degree = 300-600 and Unlimited = below 500	18.182	50
Total demand (Pers.) = 5000-10000	Unlimited = 500-1000 and above Bachelors degree = below 20	18.182	50
posts = 2000-3000	Unlimited = 500-1000 and above Bachelors degree = below 20	18.182	50
posts = 1000-2000	Unlimited = 500-1000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 5000-10000	Unlimited = below 500 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 5000-10000	above Bachelors degree = below 20 and Bachelors degree = below 300	36.364	50
Total demand (Pers.) = 10000-15000	Unlimited = above 1000 and below Bachelors degree = 1000-2000	18.182	50
Total demand (Pers.) = 10000-15000	Unlimited = above 1000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 10000-15000	Unlimited = above 1000 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 10000-15000	Unlimited = below 500 and Bachelors degree = below 300	18.182	50
posts = 2000-3000	Unlimited = above 1000 and above Bachelors degree = below 20	18.182	50

posts = 1000-2000	Unlimited = below 500 and above Bachelors degree = below 20	18.182	50
posts = 1000-2000	Unlimited = below 500 and Bachelors degree = below 300	18.182	50
posts = 2000-3000	above Bachelors degree = below 20 and Bachelors degree = below 300	36.364	50
Total demand (Pers.) = 20000-25000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 20000-25000	Unlimited = 500-1000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 20000-25000	Unlimited = above 1000 and below Bachelors degree = 1000-2000 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 5000-10000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600 and Unlimited = below 500	18.182	50
Total demand (Pers.) = 10000-15000	below Bachelors degree = 500-1000 and Bachelors degree = 300-600 and Unlimited = below 500	18.182	50
Total demand (Pers.) = 5000-10000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20	18.182	50
Total demand (Pers.) = 5000-10000	Unlimited = 500-1000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
posts = 2000-3000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20	18.182	50
posts = 2000-3000	Unlimited = 500-1000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
posts = 1000-2000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20	18.182	50
posts = 1000-2000	Unlimited = 500-1000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 10000-15000	Unlimited = above 1000 and below Bachelors degree = 1000-2000 and Bachelors degree = below 300	18.182	50

Total demand (Pers.) = 20000-25000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
Total demand (Pers.) = 5000-10000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
posts = 2000-3000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50
posts = 1000-2000	Unlimited = 500-1000 and below Bachelors degree = 1000-2000 and above Bachelors degree = below 20 and Bachelors degree = below 300	18.182	50

Appendix 6: Triple exponential smoothing method /MATLAB

```
clc,clear
yt=load('shuju.txt');
% Raw data is stored as a column vector in a plain text file
n=length(yt);
alpha = 0.8;
st1(1)=yt(1);
st2(1)=st1(1);
st3(1)=st2(1);     % Selection weighting factor
for i=2:n
    st1(i)=alpha*yt(i)+(1-alpha)*st1(i-1);
    st2(i)=alpha*st1(i)+(1-alpha)*st2(i-1);
    st3(i)=alpha*st2(i)+(1-alpha)*st3(i-1);
end
xlswrite('fadian1.xls',[st1',st2',st3'])
% Write the data to the first two columns in the form Sheet1
at=3*st1-3*st2+st3;
bt=alpha/(2*(1-alpha))*((6-5*alpha)*st1-2*(5-4*alpha)*st2+(4-3*alpha)
*st3);     % Seeking model
ct=alpha*alpha/(2*(1-alpha)*(1-alpha))*(st1-2*st2+st3);
yhat=at+bt+ct;
% The last component is the predicted value for the next month.
xlswrite('fadian1.xls',yhat','Sheet1','C2')
% Write the predicted value to column 2
str=['C',int2str(n+2)];
% Prepare to write a string of predicted position values for the next year
```

```
xlswrite('fadian1.xls',at(n)+2*bt(n)+4*ct(n),'Sheet1',str)
%Write the next month's forecast to the appropriate location
```

Appendix 7: Model fitting

Model fitting											
Fitting statistic	Mean	SE	Minimum value	Maximum	Percentile						
					5	10	25	50	75	90	95
Smooth R square	.840	.	.840	.840	.840	.840	.840	.840	.840	.840	.840
R square	.718	.	.718	.718	.718	.718	.718	.718	.718	.718	.718
RMSE	12242.789	.	12242.789	12242.789	12242.789	12242.789	12242.789	12242.789	12242.789	12242.789	12242.789
MAPE	42.156	.	42.156	42.156	42.156	42.156	42.156	42.156	42.156	42.156	42.156
MaxAPE	420.292	.	420.292	420.292	420.292	420.292	420.292	420.292	420.292	420.292	420.292
MAE	7565.160	.	7565.160	7565.160	7565.160	7565.160	7565.160	7565.160	7565.160	7565.160	7565.160
MaxAE	41012.428	.	41012.428	41012.428	41012.428	41012.428	41012.428	41012.428	41012.428	41012.428	41012.428
Normalized BIC	19.024	.	19.024	19.024	19.024	19.024	19.024	19.024	19.024	19.024	19.024

Appendix 8: Scheme layer judgment matrix

B1	C1	C2	C3	C4	B2	C1	C2	C3	C4
C1	1	3	1/3	7	C1	1	3	5	1/2
C2	1/3	1	1/4	3	C2	1/3	1	3	1/3
C3	3	4	1	5	C3	1/5	1/3	1	1/5
C4	1/7	1/3	1/5	1	C4	2	3	5	1
B3	C1	C2	C3	C4	B4	C1	C2	C3	C4
C1	1	1/3	1/5	1/3	C1	1	3	2	1/3
C2	3	1	1/4	4	C2	1/3	1	3	1/4
C3	5	4	1	5	C3	1/2	1/3	1	1/5
C4	3	1/4	1/5	1	C4	3	4	5	1
B5	C1	C2	C3	C4	B6	C1	C2	C3	C4
C1	1	3	6	1/2	C1	1	4	1/5	5
C2	1/3	1	4	1/4	C2	1/4	1	1/3	5
C3	1/6	1/4	1	1/5	C3	5	3	1	3
C4	2	4	5	1	C4	1/5	1/5	1/3	1
B7	C1	C2	C3	C4	B8	C1	C2	C3	C4
C1	1	3	6	6	C1	1	1/2	1/2	2

C2	1/3	1	1/3	4	C2	2	1	1/3	3
C3	1/6	3	1	5	C3	2	3	1	5
C4	1/6	1/4	1/5	1	C4	1/2	1/3	1/5	1

Appendix 9: Ahp method /MATLAB

```
clc,clear
fid=fopen('txt3.txt','r');
n1=8;n2=4;
a=[];
for i=1:n1
 tmp=str2num(fgetl(fid));
 a=[a;tmp]; %Reading criteria layer judgment matrix
end
for i=1:n1
 str1=char(['b',int2str(i),'=[];']);
 str2=char(['b',int2str(i),'=[b',int2str(i),';tmp];']);
 eval(str1);
 for j=1:n2
 tmp=str2num(fgetl(fid));
 eval(str2); %Reading matrix
 end
end
ri=[0,0,0.58,0.90,1.12,1.24,1.32,1.41,1.45]; %Consistency indicator
[x,y]=eig(a);
lamda=max(diag(y));
num=find(diag(y)==lamda);
w0=x(:,num)/sum(x(:,num));
cr0=(lamda-n1)/(n1-1)/ri(n1)
for i=1:n1
[x,y]=eig(eval(char(['b',int2str(i)])));
 lamda=max(diag(y));
 num=find(diag(y)==lamda);
 w1(:,i)=x(:,num)/sum(x(:,num));
 cr1(i)=(lamda-n2)/(n2-1)/ri(n2);
end
cr1, ts=w1*w0, cr=cr1*w0
```

Appendix 10: Grey association method /MATLAB

```
clc, clear
a=[3.71 2   4.86    3.29    2.57    4.86    3.71    4.43    3   3.43
3.29
3.6 3.1 4.2 3.9 3.6 3.8 4.3 3.9 2.9 3.7 3.2
```

```
3   2.57    4.3 4   3.43    4.14    4.43    4.14    2.86    3.86    3.57
2.83    2.83    4.5 4.17    2.83    4.17    4.17    4   3.17    3.83
3.67
3.17    3   4.17    2.83    3.33    3.17    4   3.17    3.17    3.5 3.17
3.5 2.5 4   3   3.5 4   4   3   3   4.5 3.5
3.57    3.14    3.57    4.14    2.71    3.57    4.29    3.58    3.43
3.29    3.29
2.83    3.17    5   3.67    3   3.83    4.5 3.83    2.5 4.17    3.83
];
for i=1:4    % Standardization of benefit indicators
    a(i,:)=(a(i,:)-min(a(i,:)))/(max(a(i,:))-min(a(i,:)));
end
for i=5:8  % Standardization of cost indicators
   a(i,:)=(max(a(i,:))-a(i,:))/(max(a(i,:))-min(a(i,:)));
end
[m,n]=size(a);
cankao=max(a')'  % Find the value of the reference sequence
t=repmat(cankao,[1,n])-a;
% Find the difference between the reference sequence and each sequence
mmin=min(min(t));   % Calculate the minimum difference
mmax=max(max(t));  %计算最大差
rho=0.5; % Resolution coefficient
xishu=(mmin+rho*mmax)./(t+rho*mmax)
% Calculate the grey correlation coefficient
guanliandu=mean(xishu)   % Equal weight, calculate relevance
[gsort,ind]=sort(guanliandu,'descend')
% Sort the relevance by big to small
```

Appendix 11： PCA method /MATLAB

```
clc,clear
gj=[3.71    3.6 3   2.83    3.17    3.5 3.57    2.83
2   3.1 2.57    2.83    3   2.5 3.14    3.17
4.86    4.2 4.3 4.5 4.17    4   3.57    5
3.29    3.9 4   4.17    2.83    3   4.14    3.67
2.57    3.6 3.43    2.83    3.33    3.5 2.71    3
4.86    3.8 4.14    4.17    3.17    4   3.57    3.83
3.71    4.3 4.43    4.17    4   4   4.29    4.5
4.43    3.9 4.14    4   3.17    3   3.58    3.83
3   2.9 2.86    3.17    3.17    3   3.43    2.5
3.43    3.7 3.86    3.83    3.5 4.5 3.29    4.17
3.29    3.2 3.57    3.67    3.17    3.5 3.29    3.83
];
```

```
% Save the original data in plain text file pjsj.txt
gj=zscore(gj); % Data standardization
r=corrcoef(gj);
% Calculating the correlation coefficient matrix
% The principal component analysis is performed by using the
%correlation coefficient matrix. The column of x is the
%eigenvector of r, that is, the coefficient of the principal component.
[x,y,z]=pcacov(r)
% y is the eigenvalue of r, and z is the contribution rate of
%each principal component
f=repmat(sign(sum(x)),size(x,1),1);
% Construct a matrix with elements of the same dimension of x as ±1
x=x.*f
% Modify the sign of the feature vector, multiplying each feature vector
%by the sign function value of all component sums
num=3;  % Num is the number of selected principal components
df=gj*x(:,[1:num]);  % Calculate the score of each principal component
tf=df*z(1:num)/100; % Calculating the composite score
[stf,ind]=sort(tf,'descend');  % Sort the scores from highest to lowest
stf=stf', ind=ind'
```