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Combined Model-based Prediction on the Scale of Professional & Technical Talents in the End of the 13th Five-Year Plan Period of Guizhou, China

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Abstract. The professional and technical talents are the significant supporting factor for the leap-forward development of economy and society, for the timely-completed political task of overcoming poverty and for the overall construction of moderately prosperous society in all aspects during the period of Five-Year Plan. Therefore, it is particularly urgent for Guizhou Province to study the scale of professional and technical talents due to the change of development strategy. In this study, based on the development of professional and technical personnel in Guizhou. The study constructed the forecast model, which is the combination of regression model and gray model. Besides, the study tried to circumvent the inherent limitations of single forecasting model with the purpose of improving the accuracy and scientific of forecasting, inspiring and enlightening the scientific development of Guizhou Province.

Keywords: the professional & technical talents; scale prediction; combined model.

1. Introduction

Professional technicians are the ones who are educated and trained professionally, who obtain professional knowledge and technical skills in a certain area. They are very much creative which make them qualified and specialized in skilled job, scientific work, research in social sciences and theory, as well as organization and management [1]. Being an important part of talents resources, professional technicians are equal to professional human capital, which undoubtedly become a key force to push the development of society and economy and to improve regional innovation capability. The premise and basics of the development of regional economy and society is scientific talent planning, while the key to set out the talent planning is the prediction of the future talent scale. Therefore, how to predict the talent scale in a region and area scientifically and exactly? How to avoid the abuse of sole prediction method and how to improve relative precision of the prediction of talent scale? And finally, what is the professional talent scale like when it's at the end of the Thirteenth Five-Year Plan in Guizhou Province? In this article, all answers to the above questions will be given and the answers give a significant meaning to governmental understanding of its regional human resources work, talent development trend. Return prediction model and grey prediction model will be combined in the article to scientifically and precisely predict professional talent scale of Thirteen Five-Year Plan in Guizhou Province, to give an inspiration to the Province to better work out development planning.

2. Literature Review

After a careful review and research of the current literature, we can find out that the academic world has achieved a fruitful research finding in the professional talent developing, talent scale and the internal link between human capital and economic growth.

In the research of human capital, Gong, C.Y. investigated the impact of human capital inequality on Total Factor Productivity (TFP) in China. The study reveals that human capital inequality has a significant negative effect on TFP, and high-quality human capital has a significant positive effect on TFP [2]. Gao, J. thought that the human capital is divided into two kinds of types: heterogeneous human capital and coessential human capital, it is the heterogeneous human capital in the human capital, which leads to the emission reduction effect of FDI [3]. Hejase, H.J., Hejase, A.J., Tabsh, H.

and Chalak, H.C. thought that the Intellectual Capital is the knowledge that individuals put into advantage in their respective companies; as such, it is an organizational competitive advantage and helps in value creation. And meantime, they discussed "Intellectual Capital" as a modern HR concept that has influenced business processes and plans. In addition, they focused on how to exploit and retain Intellectual Capital and identifies the financial and non-financial organizational benefits gained by employees. Changes occurring in environment of organization require a new attitude toward the structure of its capital (taking human, structural, and intellectual capital into account) and toward the measurement of elements that are a major source of the development of its competitiveness and goodwill [4]. Marek Kunasz. presented the notion of intellectual capital both employing narrower and wider perspectives as well as historical outline of the way in which the concept of intellectual capital was developed paying special attention to pioneering works connected with issues relating to measuring intellectual capital and classification of its structuralizing elements [5]. Niringiye Aggrey, Luvanda Eliab, Shitundu Joseph. used firm level panel data to investigate relevant importance of human capital variables in explaining labor productivity in East African manufacturing firms. Based on generalized least squares to estimate the human capital model, they indicated that proportion of skilled workers and average education and training were positively associated with labour productivity [6]. Research-based view studies indicated that companies can distinguish themselves in competition through a profound understanding of their resources and through continuous improvement of their human competencies. Evidence-based human resource management argues that gaining competitive advantage through human capital development should be verified and estimated scientifically. Kesti, M. and Syväjärvi, A. presented the scientifically solid theory of Human Capital Production Function, which explains tangible and intangible human capital's worth to business scorecards in terms of profit and loss account metrics. And illustrated how Human Capital Production Function explains human resource management's essential role in supporting strategic aims in either achieving cost advantage or differentiation advantage [7].

In the research of the internal link between human capital and economic growth, Gao, S.Y. believed that human capital has become an important drive force to economical and social sustainable development in the era of knowledge-driven economy. Different from the talent meaning, though, there exists very close connection between them. Human capital means a particular ability that human beings own, while the talent means people who own particular ability. Ordinary talents also are called foundation human capital, advanced talents equal to professional human capital which is a pattern of manifestation when human capital gathers to a certain extent [8]. Bils, M. and Klenow, P. took enrollment rate as measurement index of human capital, they researched and found that there are significant positive correlation between human capital and economic development [9]; Wang, Y. analyzed the cumulative data of economic development and human capital in a consecutive 47 years, he pointed out that consistent economic increase is a contribution of successive accumulation of human capital [10]; Based on the inspection of the changing trend of the regional economy gap in 80s and 90s, Wang, X.L. analyzed the flow of regional human capital and other production factors and made a conclusion that human capital cumulation difference is the key factor to regional economic difference [11]; by the way of setting up an assessment system of human capital and through a demonstration of the relationship of human capital and economy development in Zhejiang Province, Sun, J.S. concluded that human capital have an obvious influence on economic development [12]; Liu, X.Y. indicated that the major factor to boost regional economy coordinately and quickly is human capital, when the solid evidence analysis were done [13]. Wang, Y. and Liu, S.S. constructed a panel data model to investigate the effect of education human capital on economic growth, using the latest education data of 55 countries and regions from 1960 to 2009. Meantime, by subdividing education human capital into higher education, secondary education and primary education, they also examined the effect of different education level on economic growth. Furthermore, they explored the influence of different economic development level and some important historical events. The result shows that in general, education human capital has a significant positive impact on economic growth. The positive impact of higher education on economic growth is especially significant, as for human capital, life expectancy and per capita GDP growth also showed

a significant positive correlation [14]. Mankiw N G, Romer D, Weil D N. examined whether the Solow growth model is consistent with the international variation in the standard of living. It shows that an augmented Solow model that includes accumulation of human as well as physical capital provides an excellent description of the cross-country data. The evidence indicates that, holding population growth and capital accumulation constant, countries converge at about the rate the augmented Solow model predicts [15]. All the researches of these scholars make it clear that talent scale plays an important role of supporting in terms of regional economic growth.

In the research of the professional and technical talents, the researchers are divided into two main sides. Some of the researchers focus on the question that how are the professional and technical talents team built in specific region and field. Xu, X.L. analyzed and made the prediction on the quantity of professional and technical talents based on the gray dynamic model [16].

In the research of talent scale, some scholars focused the research on the talent scale optimizing and controlling problem. Bhukuth, A., Roumane, A., Terrany, B. investigated a simple theoretical model of cooperative organizations which are capable of enhancing its members' human capital through efficient management of all their abilities. Thus, increased human capital has impact on the household's wealth and consumption. Cooperatives can help alleviate poverty in developing countries [17]. Based on reinvestigate the effects of childhood mortality decline during different periods on human capital accumulation and economic development. Hirota, Y. extended the basic framework of Azarnert (2006) by dividing childhood among three periods—early childhood (the period prior to school enrolment), school age (the school-enrolment period), and late childhood (the period posterior to school enrolment)—and assume a constant mortality rate for each period. And arrived at the conclusions that the mortality decline after school age promotes human capital accumulation and economic development. The mortality decline after early childhood impedes human capital accumulation and economic development, but has no effect on the same after late childhood [18]. But other scholars concerned that the measures of talent prediction, Zhang, C.Z. researched the cultivation of high-level talents by employing the gray system theory. In order to certify that high-level talents are supportive of national economy, he established the new gray relation model and scale prediction model of high-level talents and national economy. And what he did enhances the accuracy and validity of talents prediction model [19]. Wang, Y.M. established the multi-objective combined prediction model which based on the fuzzy comprehensive evaluation and elaborated the deterministic process of weight [20]. Gao, L. put forward an approach of talents scale prediction which based on the Solow residual value method and he gave us an example of how to calculate it [21]. Furthermore, few scholars paid attention to the scale prediction on the reversal of international brain drain.

Based on the carding of related research literature, it is found that there are many kinds of models and methods to predict the scale of talents, but different models and methods have their own advantages and disadvantages. Most of the existing scholars tend to predict the scale of talent based on a single model, thus neglecting the inherent limitations of a single forecasting model to a certain extent, which will ultimately reduce the accuracy and reliability of the forecasting results; in addition, in the existing research on the scale of talent, there are no scholars involved in the study of the scale of professional and technical talents. There is no doubt that the previous studies of many scholars provide ideas and methods for the prediction of the scale of professional and technical talents in Guizhou Province. Therefore, while drawing lessons from the former scholars' models and methods, this study attempts to combine the regression forecasting model with the gray forecasting model, so as to carry out the forecasting research on the scale of the professional and technical talents in Guizhou Province during the 13th Five-Year Plan period. It aims to overcome the inherent drawbacks of a single model, improve the scientific nature of the forecasting method and the accuracy of the forecasting results, and finally give some inspiration to the talent development work of Guizhou Province during the 13th Five-Year Plan period.

3. Measures

3.1 Data Sample and Procedure

The data sample consisted of the per capita GDP and the quantity of professional and technical talents for six consecutive years from 2011 to 2016 in Guizhou Province, China. The combination forecasting model constructed in this study is based on and contains the two methods which are most frequently used and mature in the current forecasting research, namely regression forecasting model and gray forecasting model. Although these two methods are the most widely used, there are still some limitations in the practical application, the results will also produce some errors, and the accuracy of the prediction results is often less than expected. As a result, the main research ideas of this study are as follows. Firstly, the correlation analysis should be carried out on the professional and technical talents statistics of Guizhou Province for six consecutive years during the 13th Five-Year Plan period. By seeking the degree of correlation between the two, this study demonstrates the endogenous relationship between economic development and professional and technical talents. Secondly, the regression forecasting model and gray forecasting model should be used to predict the scale of professional and technical talents at the end of the 13th Five-Year Plan in Guizhou Province. Thirdly, the combined forecasting model based on the two forecasting models should be constructed by using the expert weight method. Finally, the combined forecasting model should be used to analyze the scale of professional and technical talents in Guizhou Province at the end of the 13th Five-Year Plan period, so as to obtain the final prediction results of the scale of professional and technical talents at the end of the 13th Five-Year Plan period in Guizhou Province.

3.1.1 Correlation Analysis

In this study, the professional and technical talents is an important factor affecting the regional economic development and innovation ability. Only to reach a certain scale, regional professional and technical talents will play its due role in supporting the economy. However, based on the level of economic development to predict the scale of professional and technical talents, the premise is that there is a high degree of correlation between the two. Therefore, before forecasting the scale of professional and technical talents, the correlation between the two must be analyzed.

Table 1. Per capita GDP, the quantity of professional and technical talents (2011-2016)

Year	2011	2012	2013	2014	2015	2016
Per capita GDP (Yuan)	16413	19710	23151	26437	29847	33242
The quantity of talents (ten thousand)	82.8	84.2	95.83	98.74	115.13	124.32

Source: China Statistical Yearbook of 2016, survey data from research group.

The data analysis function of excel is used to analyze the correlation between the original data which is presented in Table 1. The results, which is presented in Table 2, show that the correlation coefficient between per capita GDP and the quantity of professional and technical talents is 0.975, which is obviously a high correlation. This indicates that there is a strong correlation between the scale of professional and technical talents and the level of economic development, and the supporting effect of professional and technical talents on economic development is obvious. Based on the regression analysis and modeling of the per capita GDP and the quantity of professional and technical talents in Guizhou Province for six consecutive years, this study predicts the feasibility of the total amount of professional and technical talents in whole Guizhou Province at the end of the 13th Five-Year Plan period.

Table 2. Correlation analysis of per capita GDP and the quantity of professional&technical talents

	Per capita GDP	The quantity of talent
Per capita GDP	1	
The quantity of talent	0.975279	1

3.2 GM(1,1) based Scale Prediction on the Professional&Technical Talents

3.2.1 Model Construction

According to the annual statistical data of Guizhou Province, the data from 2011 to 2016 are taken as a time series, thus obtaining the scale forecasting model of professional and technical talents in Guizhou.

First of all, according to the statistical data of professional and technical talents in Guizhou Province. The original data, which is presented in Table 3, are sorted into the time series of professional and technical talents in Guizhou Province, accordingly, obtaining the date set of the amount of professional and technical talents in Guizhou Province: $X^{(0)}(k) = \{x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), x^{(0)}(4), x^{(0)}(5), x^{(0)}(6)\} = \{82.8, 84.2, 95.83, 98.74, 115.13, 124.32\}$.

Table 3. The quantity of professional& technical talents between 2011 and 2016 in Guizhou

Sequence number	1	2	3	4	5	6
Year	2011	2012	2013	2014	2015	2016
The quantity of talents (ten thousand)	82.8	84.2	95.83	98.74	115.13	124.32

Then, an accumulative operation is performed on the above series: $X^{(1)}(k) = \{82.8, 167, 262.83, 361.57, 476.7, 601.02\}$.

Finally, with the help of gray system method in DPS data processing system, GM (1,1) is used to analyze and predict the data. and then the results are summarized in Table 4 and Table 5.

Table 4. The results of GM (1,1) based analysis

Sequence number	Actual value	Fitted value	Error	Error rate
X(2)	84.2	84.8978	-0.6978	-0.8288
X(3)	95.83	94.4992	1.3308	1.3887
X(4)	98.74	99.2321	-0.4921	-0.4984
X(5)	115.13	115.3024	-0.1724	-0.1497
X(6)	124.32	124.2893	0.0307	0.0247

The results of analysis, which is presented in Table 4, show that the average error between the fitted value and the actual value is -0.00016, and the average error rate is -0.0127, both of which are within the acceptable error range. The data are carried on the residual analysis twice by DPS gray model, and then the results of prediction analysis and the model of predicting the scale of professional and technical talents, which is presented in Table 5, are obtained.

Table 5. The results of GM (1,1) based prediction

Sequence number	Predicted value
X(t+1)	137.343
X(t+2)	151.22794
X(t+3)	166.5207
X(t+4)	183.36391
a=0.0235,b=0.7217	X(t+1)=-0.29.970046exp(-0.02356t)+30.635776

3.2.2 The Test of Model Precision

The accuracy test of the prediction model is an important basis for judging the accuracy and feasibility of the model. Generally speaking, it is necessary to test the residual error and posterior error of the prediction model in order to determine the accuracy and utility of the prediction model when using the gray model to predict. After testing, the posterior error ratio, error probability value and average relative error value of the prediction model are presented in Table 6. Referring to the evaluation criterion of accuracy grade of the model which is presented in Table 7, the accuracy grade of the prediction model can be determined to be excellent, and the feasibility of the model is strong and the reliability of the prediction result is high.

Table 6. Parameter value of the prediction model precision

Checking index	Parameter value
P	1
C	0.0468
Q_{min}	-0.69784

Table 7. The evaluation criterion of accuracy grade of prediction model

Checking index	Excellent	Good	Average	Weak
P	≥0.9	≥0.8	≥0.7	<0.7
C	<0.35	<0.5	<0.65	≥0.65

3.3 Linear Regression Model based Scale Prediction on the Professional &Technical Talents

3.3.1 Model Construction

When the data distribution of two pairs of variables is generally linear, the one variable linear regression model can be obtained by using the parameter estimation method to express the relationship between independent variables and dependent variables, and to predict the trend of dependent variables. Talents must develop harmoniously with economy and society, so several economic and social development goals of target year determined in the overall plan of national economic and social development are the important basis for forecasting the scale of talents(Li Tao, Song Guangxing,2006). Among the many factors that affect the total quantity of professional and technical talents, the level of economic development has the most obvious impact on professional and technical talents, and the development of professional and technical talents can only play its due role in economic support if it reaches a scale that is commensurate with the level of economic development. Therefore, this study selects per capita GDP as the independent variable, takes the total quantity of professional and technical talents as the dependent variable, and carries on the one variable linear regression analysis to the relationship between the two with the help of regression analysis tool in excel, thus forecasting the total scale of professional and technical talents at the end of the 13th Five-Year Plan.

In the mathematical statistical analysis of independent and dependent variables with causal relationship, only when there is a certain relationship between them, the established regression equation is meaningful. Therefore, whether the two are related or not and the degree of correlation are the most important problems to be solved by regression analysis. The statistics of per capita GDP and the quantity of professional and technical talents in Guizhou Province for six consecutive years are presented in Table 8, with the continuous development of economy in Guizhou , it can be found that the quantity of professional and technical talents has accordingly shown a trend of increasing year by year.

Table 8. Per capita GDP, the quantity of professional and technical talents (2011-2016)

Year	2011	2012	2013	2014	2015	2016
Per capita GDP(Yuan)	16413	19710	23151	26437	29847	33242
The quantity of talents (ten thousand)	82.8	84.2	95.83	98.74	115.13	124.32

Source: China Statistical Yearbook of 2016, survey data from research group.

According to the corresponding increasing trend of the two sets of data, it can be preliminarily determined that there is a linear correlation between the two sets of data. Furthermore, using statistical regression analysis tool of excel, this study makes linear regression analysis on the statistics data of per capita GDP and the quantity of professional and technical talents for six consecutive years during the 12th Five-Year Plan period in Guizhou Province, and depicts the relationship between the two by using linear fitting linear graph. It can be seen that the development trend of the quantity of professional and technical talents tends to a straight line during the 12th Five-Year Plan period in Guizhou Province, at the same time, we can get a linear regression equation(Y=0.0026X+36.271) to

fit the straight line. This verifies that there is indeed a linear correlation between GDP per capita as an independent variable and the quantity of professional and technical talents as an independent variable. Therefore, it is assumed that the regression model equation can be used to predict the scale of professional and technical talents in Guizhou Province at the end of the 13th Five-Year Plan period.

3.3.2 Rationality Test

After the preliminary assumptions mentioned above, there is a linear positive correlation between the economic development and the quantity of professional and technical talents in Guizhou Province during the 12th Five-Year Plan period, but the rationality of the linear regression model needs to be tested by the following three significant levels.

Firstly, the goodness of fit of the regression model is tested and is presented in Table 9. The multiple correlation coefficient ——"Multiple R" is used to measure the degree of correlation between independent variables and dependent variables. The test result of the model is R=0.975, which indicates that the relationship between them is highly positive correlation, and the coefficient of multiple determination ——"R Square" is used to explain the degree of variation of dependent variable in order to determine the fitting effect of dependent variable. According to the discriminant standard of R2, the range of values is [0-1], and the closer to 1, the higher the goodness of fit of regression model is. The test results of this model show that the judgment coefficient R2 =0.95, which indicates that the independent variable can explain 95% of the variation of the dependent variable, and the adjusted coefficient of multiple determination ——"Adjusted R Square" shows that the independent variable can explain the degree of the dependent variable. The results of the model test show that the adjusted coefficient of multiple determination is 0.939, which indicates that the independent variable can explain 93.9% of the dependent variable and 6.1% of the dependent variable is explained by other factors; while the standard error is used to measure the size of the degree of fit, and the smaller the value is, the better the fitting degree of regression model is. The test results of this model show that the standard error value is 4.11, which indicates that the fitting degree of the model is high. Through the test of goodness of fit for the regression model of statistical data during the 12th Five-Year Plan period, it can be determined that there is a high positive correlation between the two, and the regression model has a good goodness of fit.

Table 9. Test of goodness of fit

Checking index	Parameter value
Multiple R	0.975279333
R Square	0.951169778
Adjusted R Square	0.938962222
Standard error	4.111367567
Observed value	6

Secondly, F-value test is used for the variance test in the regression model and presented in Table 10. The main function is to determine the regression effect of the regression model through F-value test. One of the most important indicators is the value of "significance F". Generally speaking, its value should be less than 0.01, the smaller the value, the higher the level of significance of the regression model. The "significance F" value of the F test of the model is 0.000909114, which is far less than the significance level value of 0.01. It can be judged that the regression model has passed the significance level test, and its regression effect is remarkable.

Table 10. F-value test

	Df	SS	MS	F	Significance F
Regression analysis	1	1317.05	1317.05	77.92	0.000909114
Residual error	4	67.61	16.9		
Aggregate	5	1384.66			

Table 11. T-value test

	Coefficients	Standard error	t Stat	P-value	Lower 95%	Upper 95%	Lower limit 95.0%	Upper limit 95.0%
Intercept	36.270935	7.4310597	4.880991	0.0081548	15.63901	56.902865	15.63901	56.902864
X Variable 1	0.002577	0.0002919	8.827031	0.0009091	0.001766	0.003387	0.001766	0.003387

Finally, T-value test is used to test the significance of the independent variables of the regression model and is presented in Table 11. Among them, the most critical reference index is the value of "P-value". The smaller the value of intercept T test value ——"Intercept P-value", the more significant the regression effect; The smaller the value of T test of independent variable ——"X Variable 1 P-value", the more significant the regression effect. The test results of this model show that the intercept test value is 0.0082, and the independent variable test value is 0.0009, which indicates that the regression effect of the model is better.

3.3.3 Results

Through the construction of the above model and its significance test, the results show that there is a significant positive correlation between the quantity of professional and technical talents and per capita GDP, and this model is reasonable and scientific for the prediction of professional and technical talents in Guizhou Province during the 13th Five-Year Plan period. Therefore, according to the 13th Five-Year Plan for Economic and Social Development of Guizhou Province, the per capita GDP of Guizhou Province is required to reach 50,000 yuan in 2020, and the scale of professional and technical talents in Guizhou Province can be calculated by using this model.

3.4 Combined Model-based Prediction on the Scale of Professional & Technical Talents

Through the analysis of the relevant literature, it is found that there is more than one forecasting method for the scale of talents in academia, which includes forecasting models that meet different objectives, but each one has its own advantages and disadvantages. Therefore, this study makes the following assumptions: assuming that there are n models that have passed the statistical test to predict the scale of professional and technical talents, and after passing the test of rationality, we can select r models that are more satisfactory. Finally, the combination model of forecasting the scale of professional and technical talents is obtained by using the systematic forecasting method, that is

$$Fr = \sum_{i=1}^{r} Wi * Fi \Big/ (W1 + W2 + \cdots + Wr)$$

Comment:
Fr—combined predicted value of talent scale.
Fi—predicted value.
Wi—weight.

3.5 Discussion

The combined forecasting model adopted in this study includes two different forecasting methods: regression model and gray model. At first, on the basis of constructing the two models and testing their accuracy, the expert weight method is used to weight the two models and the result is presented in Table 12. Then the predicted results of the two models are introduced into the combined forecasting model, and finally the combined forecasting value of the scale of professional and technical talents in Guizhou Province is obtained.

Table 12. Combined model-based prediction on the talents scale

Category / Model	Prediction model	Predicted value	Weight(W)
Regression model	Y=0.0026X+36.271	166.271	0.6
Gray model	X(t+1)=-0.29.970046exp(-0.02356t)+30.635776	183.36391	0.4

According to the combined prediction model constructed in this study, the final predicted value of the scale of professional&technical talents at the end of the 13th Five-Year Plan period in Guizhou Province can be obtained on the basis of the predicted values and weights of each model, that is $Fr = \sum_{i=1}^{2} Wi * Fi \big/ (W1 + W2 + \cdots + Wr) = 1731100$.

The ultimate purpose of talent scale prediction is to serve decision-making, which is not only a systematic part of the whole economic and social development planning, but also the basis of educational development planning. The predicted value is the scale of the professional & technical talents in Guizhou at the end of 13th Five-Year Plan period. Through calculation, it can be found that the existing scale of professional and technical talents in Guizhou still has a gap of 487,900, which points out the direction and key point for the development of talents in Guizhou Province during the 13th Five-Year Plan period.

4. Conclusion

Based on this, this study holds that Guizhou Province should pay attention to make up the gap of 487,900 professional& technical talents in the period of 13th Five-Year Plan, promote the development of professional and technical talents through the special talent planning, and combine the introduction and cultivation of professional and technical talents. At the same time, improve the quantity of professional and technical talents, enhance the utility and retention of professional and technical talents, give full play to the supporting role of professional and technical talents to the economic and social development of Guizhou Province, and drive the promotion of innovation ability of the whole Province.

There are many factors affecting the scale of talents. This study only selects the economic factors among them as the variables of forecasting and analysis, and it is inevitable that there will be some biased places. The variable factors not involved in this study need to be further revised and improved by subsequent relevant researchers.

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