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Optimization study on the development path of urban elderly manpower resources based on decision tree algorithm

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Abstract The global aging trend is intensifying, China's elderly population over 60 years of age is growing rapidly, and the working-age population is on a downward trend. The pressure on pension expenditure is increasing, and the accumulated balance of the basic pension insurance fund is expected to be exhausted around 2035. The purpose of this study is to explore the optimization strategy of the development path of urban elderly human resources, to alleviate the pressure of the aging society, and to make full use of the “wisdom dividend” of the elderly. Based on the COM-B behavioral analysis model, a theoretical framework for the development of human resources for the elderly in urban areas is constructed by combining human capital theory, intergenerational support theory and Maslow's hierarchy of needs theory. Using the 2020 China Health and Aged Care Tracking Survey (CHARLS) data, we screened 1,210 samples of urban under-aged seniors (60-69 years old), used the SMOTE algorithm to deal with the data imbalance problem, and constructed the SMOTE-XGBoost prediction model to assess the degree of development of the elderly's human resources. The SHAP global explainable model was applied to analyze the influencing factors. The results show that the SMOTE-XGBoost model has a good predictive ability with an AUC value of 0.951; pension income, education, age, intergenerational care, and gender are the five key factors affecting the development of the strength resources of the urban elderly. The study concludes that the optimization of human resources development for the urban elderly should start from four aspects: promoting the concept of re-employment for the younger elderly, promoting vocational education for the elderly through industry-academia cooperation, improving the legal system to provide institutional safeguards, and establishing a national-level human resources development system for the elderly. This study has important theoretical and practical significance for promoting active aging, healthy aging and coping with population aging.

Index Terms Elderly Manpower Resource Development, Decision Tree Algorithm, SMOTE-XGBoost Model, SHAP Interpretable Model, Optimization Path, Urban Low-age Elders

I. Introduction

At the turn of the old and new centuries at the end of the last century and the beginning of this century, the cumulative number of elderly people aged 60 years and above in the world reached nearly 600 million, reaching 10% of the total population in that year, and by now, the world has entered the stage of aging [1], [2]. As a worldwide problem, aging was considered one of the most prominent of all social phenomena at the end of the last century, and in this century it is considered one of the major social problems that almost all countries have to face.

Along with the rapid and massive growth in the number of elderly people, it will certainly bring about significant changes in economic and social development [3]. With the arrival of the 60 “retirement wave” and the birth rate continues to decline, the working-age population will show a faster downward trend [4]. The aging population is precisely the link between the past, present and future. At present, there are a large number of experienced, knowledgeable and skilled elderly population, actively develop the elderly manpower resources, so that the willingness, physical condition allows the elderly to continue to work, the full development and utilization of the elderly population of the “wisdom dividend”, can alleviate the contradiction between supply and demand in the labor market, reduce the “demographic dividend”. The negative impact of the weakening of the “demographic dividend” on economic growth [5]-[8].

In addition, the Chinese Academy of Social Sciences released the “China Pension Actuarial Report 2019-2050” that the basic pension insurance fund will reach its peak in 2027, and the accumulated balance will be exhausted around 2035, and the active development of the resources of the elderly manpower and the increase in the retirement age of the elderly population can effectively alleviate the pressure on the expenditure of the pension insurance and medical insurance, and promote the balance of social insurance revenues and expenditures [9]-[11].

Moreover, actively developing the human resources of the elderly and increasing the economic income of families are conducive to maintaining harmonious and stable family relations, reducing family conflicts, improving the quality of family life and promoting social harmony [12]-[14]. In addition, active aging and healthy aging are the latest concepts of the World Health Organization to cope with population aging, and health, participation, and security are the three core pillars of active aging, and lifelong learning, constructing and maintaining good social relationships and participating in society are important elements of healthy aging [15], [16]. Older people give full play to their skills, experience and culture to enhance their social participation in the form of re-employment, implying that older people are not a burden to society. Rather, they are valuable assets of the whole society, reflecting the recognition and protection of the whole society of the lifelong social participation rights of the elderly, enhancing the sense of existence, value, happiness and security of the elderly, improving the physical and mental health of the elderly, and comprehensively improving the stock of human capital [17]-[20].

The current development of elderly human resources presents the phenomenon of low utilization level. Specifically, most of the enterprises recruiting age discrimination, for the age of more than 35 years old labor force to reduce the admission, talent supply and demand information mismatch. The professional skills, career planning, and health level of some of the elderly are at a level where they can work, but due to the national retirement age policy, it is difficult for them to re-enter the labor market. Moreover, the rapid development of the city makes most of the low-aged elderly people's cognition of the labor market demand biased, and the demand for standard jobs leads to the dilemma of human resource development for the elderly [21]-[24]. Therefore, how to develop urban elderly human resources, and its optimization path, is the key to constraints on aging management and urban economic development.

Population ageing has become a global social problem. At the end of the last century and the beginning of this century, the world's elderly population aged 60 years and above had reached nearly 600 million, accounting for 10 per cent of the total population at that time, and the world has now entered the stage of ageing. With the arrival of the post-60s “retirement wave” and a persistently low birth rate, the working-age population is showing a faster downward trend, and ageing is having a significant impact on economic and social development. However, the older population is the link between the past, the present and the future, and there are currently a large number of older persons who are experienced, knowledgeable and skilled. Actively developing the human resources of the elderly, allowing those who are willing and physically fit to continue working, and fully exploiting the “wisdom dividend” of the elderly population can effectively alleviate the contradiction between supply and demand in the labor market, and mitigate the negative impact of the weakening of the “demographic dividend” on economic growth. According to the China Pension Actuarial Report 2019-2050 released by the Chinese Academy of Social Sciences, the basic pension insurance fund will reach its peak in 2027, and the accumulated balance will be exhausted around 2035. Actively developing elderly manpower resources and raising the retirement age of the elderly population can effectively alleviate the pressure on pension and medical insurance expenditures and promote the balance of social insurance revenues and expenditures. In addition, actively developing the human resources of the elderly to increase family economic income is conducive to maintaining harmonious and stable family relations, reducing family conflicts, improving the quality of family life and promoting social harmony. The World Health Organization advocates the concepts of active ageing and healthy ageing, and regards health, participation and security as the three core pillars of active ageing, emphasizing that lifelong learning, the building and maintenance of good social relationships and participation in society are important elements of healthy ageing. Enhancing the degree of social participation of the elderly through re-employment can reflect the recognition and protection by society as a whole of the lifelong social participation rights of the elderly, enhance the sense of existence, value, happiness and security of the elderly, raise the level of physical and mental health of the elderly, and comprehensively enhance the stock of human capital. However, the current low level of development and utilization of human resources for the elderly is manifested in the age discrimination in recruitment by enterprises, the lowering of the acceptance ratio for laborers over 35 years of age, and the mismatch of information on the supply and demand of talents. Some older people, despite the fact that their professional skills, career planning, and physical health are all in a workable condition, have difficulty re-entering the labor market due to the restrictions of the retirement age policy. The rapid development of the city has caused most of the low-aged elderly to have a biased perception of the labor market demand, and the mismatch between the demand for standard jobs has led to the dilemma of the development of the elderly manpower resources. Therefore, this study takes COM-B behavioral analysis model as a framework, combines human capital theory, intergenerational support theory and Maslow's hierarchy of needs theory to construct a theoretical analysis framework for the development of urban elderly human resources, based on CHARLS survey data, adopts SMOTE algorithm to solve the problem of data imbalance, constructs a prediction model for the degree of development of elderly human resources based on XGBoost and applies the SHAP global interpretable model to predict the degree of development of elderly human resources, and applies XGBoost to predict the degree of development of elderly human resources. SHAP global interpretable model is used to analyze the influencing factors, and then the optimization path of urban elderly human resource development is proposed to provide theoretical basis and practical guidance for solving the problem of aging society.

II. Theoretical and analytical framework for the development of urban human resources for older persons

This chapter designs a theoretical analysis framework for the development of human resources for the urban elderly to provide theoretical guidance for exploring the optimization path of human resources development for the urban elderly.

II. A. ***Analytical framework design***

Resource development for the elderly is essentially a result of “will + behavior”, and the COM-B behavioral analysis model is an analytical framework for studying behavioral change, which mainly consists of ability, opportunity and motivation. Among them, ability mainly refers to the individual's ability to achieve behavioral change, including cognitive and physical abilities. Opportunity refers to the external environmental factors that affect the individual. Motivation is the internal driving force that prompts individuals to produce behavioral change. Based on previous studies, this study takes human capital theory, intergenerational support theory, Maslow's hierarchy of needs theory as the basis, and invokes COM-B behavioral analysis model to construct the theoretical analysis framework of urban elderly human resource development as shown in Figure 1.

First of all, individual human capital is the most important factor affecting the development of elderly human resources. According to the human capital theory, the health capital and education capital of the elderly directly determine the ability of the elderly to develop human resources. Compared with the young labor force and the middle-aged and high-aged elderly, age is one of the important variables, coupled with the tendency of the job market for men and urban elderly, so the empirical analysis of this study mainly selects the demographic characteristics of age, gender, place of residence, health, and education to measure the capacity of the development of the strength resources of the urban elderly of the younger age. Second, family factors have an important influence on the behavioral choices of older adults in terms of force resource development. According to the intergenerational support theory, the intergenerational relationship between members within the family may affect the behavior of older adults' force resource development, and many younger older adults are still the important breadwinners of their families. Therefore, this study takes family factors as the factors explaining the force resource development of urban lower-aged older adults, which mainly include marital status, the number of children, the financial support given by older adults to their children, the financial support given by their children to older adults, and the status of intergenerational care provided by older adults to their grandchildren. Finally, social security status also affects the willingness and behavior of older persons to develop their human resources. From the perspective of Maslow's Hierarchy of Needs Theory, as individuals enter the old age stage, some older people have no guaranteed income, especially the group with no pension income will obtain income through re-employment to meet their financial needs. There are also some high pension groups who are separated from their original social relationships due to retirement or joblessness and lose their sense of belonging as well as self-actualization, and they will also gain self-actualization of higher needs through re-employment. Therefore, this study takes social security status such as health insurance and pension income as motivational factors to explain the development of elderly human resources.

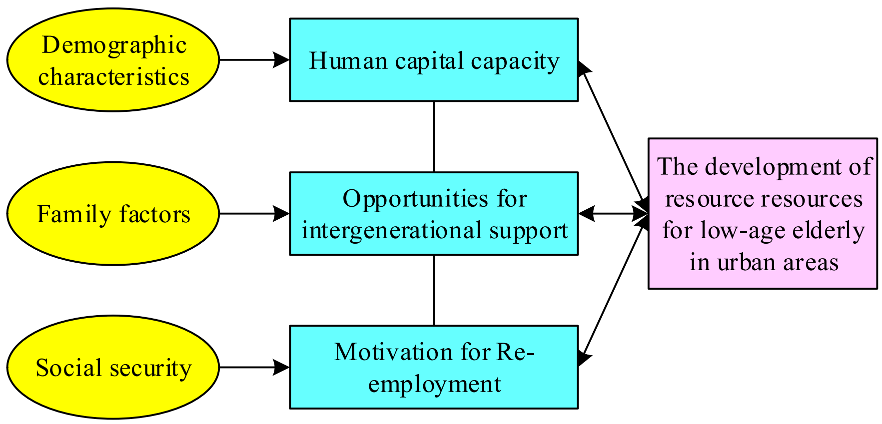


Figure 1: Theoretical Analysis framework

II. B. Data sources

The data in this article comes from the 2020 China Health and Aged Care Tracking Survey (CHARLS) organized by the National Development Research Institute of Peking University. This survey study targets middle-aged and elderly people aged 45 and above in China, and organizes and provides relevant information about this group of people, such as families and individuals, to provide high-quality micro-sample survey data for analyzing and researching relevant issues and the current situation in the field of population aging in China. In the process of data screening, the data samples were screened in conjunction with the research content of this paper, while some missing values and outliers were excluded, and a total of 1,210 respondent samples of urban underage elderly (60-69 years old) were screened. By gender, the ratio of men and women is relatively close, with 612 men and 598 women.

II. C. Description of variables

Explained variable: development of human resources of the urban under-aged elderly. Measured by the activities of the CHARLS questionnaire that involve the acquisition of economic income by the urban under-aged elderly.

Explanatory variables: first, demographic characteristics, including age, gender, place of residence, health status, and education level. The second is family factors, including marital status, number of children, financial support given by parents to children, financial support given by children to parents, and intergenerational care. The third is social security factors, including participation in health insurance and pension income status.

III. Prediction of the degree of exploitation of human resources for older persons based on the decision tree algorithm

In order to realize the effective assessment of the degree of development of urban human resources for the elderly, so as to quantitatively analyze the effectiveness of the optimization of the development path of human resources for the elderly, this chapter combines the unbalanced dataset algorithm and the decision tree algorithm to construct a prediction model of the degree of development of human resources for the elderly, SMOTE-XGBoost, and analyzes the prediction results by using the SHAP globally interpretable model.

III. A. Algorithm for unbalanced data sets

The class imbalance problem of data means that the number of one class of data is much more than other classes. If the imbalanced dataset is directly used for training in the model training process, it will easily lead to classification failure. Currently, there are four main categories of unbalanced data processing methods, which are data sampling, algorithm improvement, cost-sensitive learning and integrated learning. In this paper, four more representative data balancing algorithms, random up-sampling (Up_sample), random down-sampling (Down_sample), SMOTE [25], and cost-sensitive learning (CSL) algorithm [26], are selected to solve the imbalance problem in the dataset of manpower resource development for the urban under-aged elderly.

III. A. 1) Random upsampling and random downsampling

Random up-sampling is one of the most common methods of up-sampling, in which samples are randomly drawn from the undeveloped sample of urban low-income older adult manpower resources and added to the sample space to achieve data balance between the undeveloped and developed samples. Random downsampling is a type of downsampling method, and the idea is to balance the data categories by reducing the number of developed samples.

III. A. 2) Cost-sensitive learning

Cost-sensitive learning solves the category imbalance problem by preventing overfitting by defining different costs for misclassified positive and negative samples. For the prediction of the degree of development of urban elderly manpower resources, it is important to try to avoid misclassifying undeveloped samples as developed samples by assigning higher learning weights to the undeveloped samples, thus allowing the algorithm to focus more on the categorization of the undeveloped samples.

III. A. 3) SMOTE algorithm

The SMOTE algorithm is a method for addressing the problem of dataset imbalance by creating samples of the minority class. The SMOTE algorithm calculates the nearest K sample by distance and then randomly selects data from it to generate new samples, which is a method of synthesizing new samples based on 'interpolation'. That is:

$$x_{new} = x + rand(0,1) \times \|\hat{x} - x\| \tag{1}$$

where, x is a minority class sample, $\hat{x}$ is the nearest neighbor sample, and $\|\cdot\|$ denotes the distance formula.

III. B. *Optimization algorithm based on decision tree model*

III. B. 1) *Decision trees*

For the classification problem, assume that the data (x_i, y_i), $(i=1,2,\cdots,n)$ contains p input variables and a category-type response variable $y \in \{1,2,\cdots,K\}$ with a sample size of n. The process of modeling a classification tree is the automatic selection of the branching variable and the conditions for branching based on this variable. Assume that the data is divided into M regions, and the sample size of the m th region R_m is n_m, $(m=1,2,\cdots,M)$. Order:

$$\hat{p}_{m,k} = \frac{1}{n_m}\sum_{x_i \in R_m}(y_i = k) \tag{2}$$

Denotes the proportion of sample points in the k th class in node m, and the final predicted class of node m is $k(m) = \arg\max_k \hat{p}_{m,k}$, i.e., the class with the largest number of classes in node m. The optimal branching scheme is to minimize the impurity of the M nodes. The metrics to measure the impurity of node m are:

(1) Mis-branching rate:

$$\frac{1}{n_m}\sum_{x_i \in R_m} I\left(y_i \neq k(m)\right) = 1 - \hat{p}_{m,k(m)} \tag{3}$$

(2) Gini index:

$$\sum_{k \neq k'} \hat{p}_{m,k}\hat{p}_{m,k'} = \sum_{k=1}^{K}\hat{p}_{m,k}(1-\hat{p}_{m,k}) \tag{4}$$

(3) Entropy:

$$-\sum_{k=1}^{K}\hat{p}_{m,k}\log\hat{p}_{m,k} \tag{5}$$

In performing binary classification, if p represents the proportion of nodes m in one of the classes, then the three metrics take the values $1-\max(p,1-p)$, $2p(1-p)$, $-p\log p-(1-p)\log(1-p)$. where the Gini index and entropy are smooth and derivable, so they are often used.

III. B. 2) *XGBoost*

XGBoost is an optimization algorithm based on decision tree models, which has received widespread social attention due to its excellent learning performance and relatively fast training speed [27]. XGBoost essentially makes use of the idea of fitting residuals in Boosting algorithms.In the project of fitting a model, the prediction of the initial decision tree is generally not completely accurate, and some residuals will be present, followed by fitting the residuals with a new decision tree to fit the residuals, and repeat the step until the original predetermined conditions are met.

From the perspective of additive modeling, a decision tree-based combinatorial model can be described as K additive functions:

$$\hat{y}_t = \varphi(c_i) = \sum_{k=1}^{K} f_k(x_i),\ f_k \in F \tag{6}$$

where $F = \left\{f(x) = w_{q(x)}\right\}$ is the set of decision tree functions. The letter q represents the branching structure of the tree and w represents the weight values of the leaf nodes.The objective function for the optimization of the XGBoost method is as follows:

$$L(\phi) = \sum_i l(\hat{y}_i, y_i) + \sum_k \Omega(f_k) \tag{7}$$

In the formula:

$$\Omega(f_k) = \gamma T + \frac{1}{2}\lambda\sum_{j=1}^{T} w_j^2 \tag{8}$$

Here l is our choice of loss function, which is usually a derivable convex function. The Ω function penalizes the size of the tree as well as the weight values of the leaf nodes to prevent overfitting of the model. The objective variable of the above optimization problem is a function, so it is optimized in a stepwise forward additive way. Let $\hat{y}_i^{(t)}$ be the predicted value of the i th sample point at the t th step of the iteration, and f_t needs to be added to optimize the following objective function:

$$L^{(t)}=\sum_{i=1}^{n} l\left(y_i,\hat{y}_i^{(t-1)}\right)+f_t(x_i)+\Omega(f_t) \tag{9}$$

In this paper, this objective function is optimized using second-order approximation, so that the optimal value of leaf weights w can be found for a fixed tree structure $q(x)$. After that, the score function of the tree structure q is calculated based on the value of w, which will be used as an evaluation index to grow and prune the tree using the greedy algorithm.

III. C. ***SHAP Global Interpretable Modeling***

Shapley additive interpretation (SHAP) is a model-independent interpretation that assigns an importance value to each input feature for a given prediction, enabling an interpretable analysis of the prediction results from the perspective of the entire dataset. The Shapley additivity interpretation (SHAP) is based on the principles of cooperative game theory and the importance values obtained by calculating the contribution of features to the final prediction results using Shapley value probabilities [28]. By formulating the features of the data in a cooperative game, the Shapley value can be calculated to learn the fair distribution of payments. In this case, the characteristics of the explanatory variables for urban geriatric resource development are the characteristics used in the prediction model.

To accurately predict the extent of geriatric resource development, the contribution of each feature can be measured as the Shapley value for each feature. To calculate the Shapley value for a given explanatory variable feature, the difference between the predicted value produced when the feature is present and the predicted value produced when the feature is absent is calculated, and this difference is referred to as the marginal contribution of the given feature to the current prediction. The calculation is done for each individual combination of features and by performing the marginal contribution calculation for all the combinations, the average value of the difference in all the combinations is obtained, which is called the Shapley value.

Shapley value is calculated in SHAP as shown in equation (10) where features are used to calculate the ratio of contribution of a particular feature based on the contribution weights of all features:

$$\phi_f(x)=\sum_{s\subseteq F\setminus f}\left[|S|*\binom{|F|}{|S|}\right]^{-1} c \tag{10}$$

where ϕ denotes the Shapley value of the feature, f is the predicted value of the feature combination, and S is the feature subset. F is the complete set of available features, i.e., the number of elements in the original set. C is the marginal contribution value of adding feature F to this subset, which is calculated by Equation (11):

$$C=\left[x(s\cup f)-x(s)\right] \tag{11}$$

where $x(s\cup f)$ is the subset containing the features in s that have feature f, and $x(s)$ is the subset that does not have feature f.

SHAP values are based on the results of each possible combination of features that should be considered to determine the importance of individual features. Suppose there are three explanatory variable features (f_1,f_2,f_3), then it also means that there are $2^3=8$ possible combinations of features. Since x is the prediction task, we use the f_2 feature as an example of how to compute the SHAP value. The marginal contribution of f_2 features to a prediction model that contains only f_2 as features is shown in equation (12):

$$C_{f_2,\{f_2\}}(x)=\left[x(s\cup f_2)-x(s)\right] \tag{12}$$

In order to obtain the overall impact of feature f_2 on the final prediction, the marginal contribution of f_2 across all possible coalitions in which f_2 is present is needed. All marginal contributions f_2 are then summarized by a weighted average using the formula as shown in equation (13):

$$\phi_f(x)=w_1C_{f_2,\{f_2\}}(x)+w_2C_{f_2,\{f_2f_1\}}(x)+w_3C_{f_2,\{f_2f_3\}}(x)+w_4C_{f_2,\{f_2f_1f_3\}} \tag{13}$$

where $w_1+w_2+w_3+w_4=1$. The weights of all marginal contributions to f features should be equal, for each f, which means that the sum of the weights of all marginal contributions to one feature model is equal to the sum of the weights of all marginal contributions to two feature models.The detailed flow of the SHAP interpretable model is shown in Figure 2.

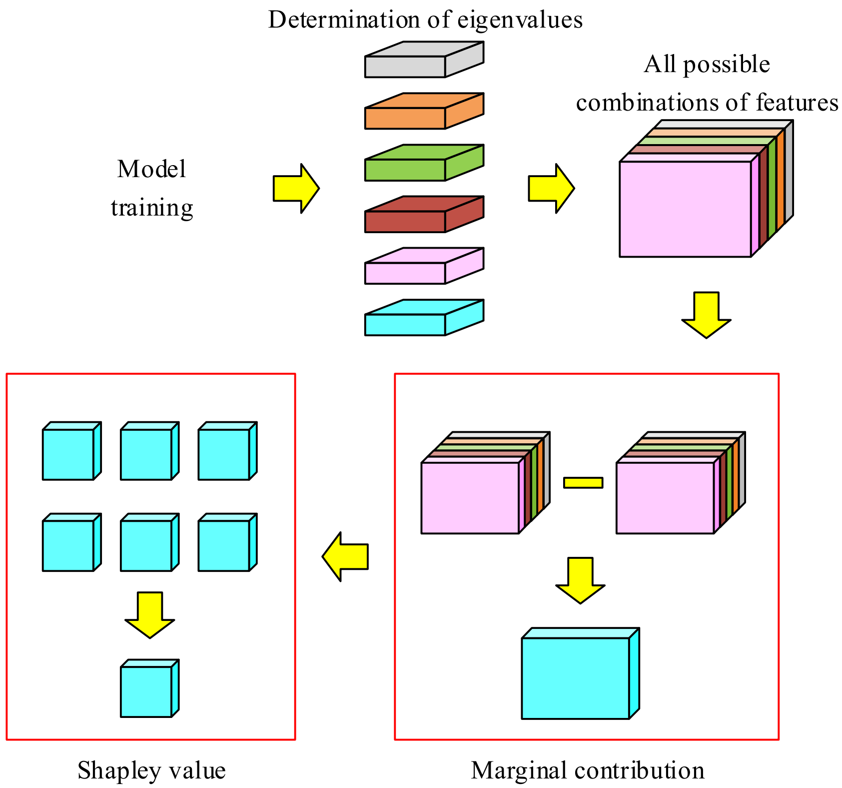


Figure 2: SHAP model flow chart

III. D. ***Experiments and analysis of results***

In order to verify the validity of the constructed prediction model of the degree of development of human resources for the elderly, this section evaluates the effectiveness of the model and analyzes the main factors affecting the development of human resources for the urban underage elderly.

III. D. 1) ***Experimental setup***

(1) SMOTE Expanded Sample

The SMOTE algorithm is used for class imbalance processing of urban elderly human resource development data. 70% of the sample set of urban elderly human resource development data H is used as the training set for class imbalance processing, and if one of the few classes of elderly human resource undeveloped sample set is W, then iterates through each 1 elderly human resource undeveloped sample.

(2) Divide the data set

The main purpose of dividing the dataset is to evaluate the performance of the model on different data subsets in order to reduce the risk of overfitting and to enhance the model's ability to predict unknown data. Therefore, in order to effectively ensure the model's generalization ability and the robustness of parameter calibration, this paper randomly divides the dataset into the training set and the test set in the ratio of 7:3.

(3) Parameter optimization

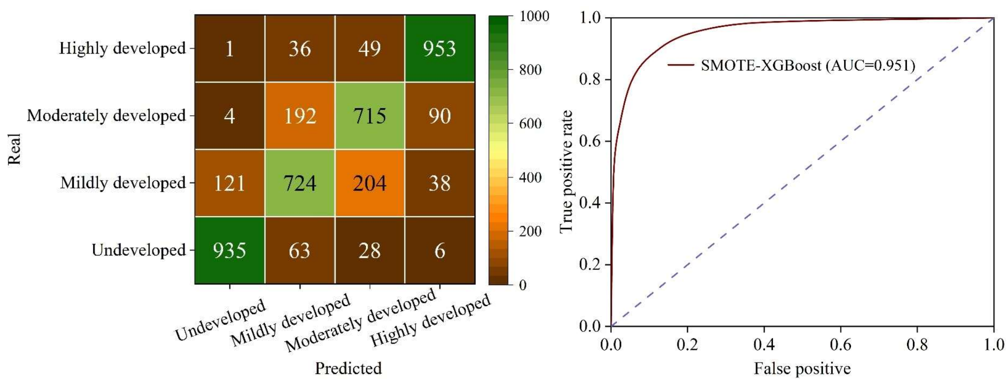
XGBoost itself has $\mathrm{xgboot.cv}(\ )$ method of parameter tuning, this paper utilizes the grid search and cross-validation to find the optimal parameter combinations, and adopts the $\mathrm{xgboot.cv}(\ )$ method for manual parameter tuning, and the parameter tuning values are shown in Table 1.

Table 1: Parameter tuning values

Parameter name	Value
booster	gbtree
use_label_encoder	false
n_estimators	1200
max_depth	10
num_calss	5
Min_child_weight	0.5
Colsample_bynode	0.7
subsample	0.7
learning	0.07

III. D. 2) ***Forecast of the degree of development of human resources for the elderly***

The optimal SMOTE-XGBoost model was obtained after the parameter tuning was completed, at which point the model was trained based on the training set. The generalization ability of the model is tested using the test set samples and the confusion matrix results as well as the ROC curves are shown in Fig. 3. Where, (a) and (b) are the confusion matrix and ROC curve, respectively, and the AUC value of the area under the ROC curve to test the prediction accuracy of the prediction model of the degree of development of urban elderly manpower resources.The AUC value of the SMOTE-XGBoost combination model is 0.951, that is, the models all have good prediction ability.



(a) Confusion matrix (b) ROC curve

Figure 3: Confusion matrix and ROC curve of the SMOTE-XGBoost model

III. D. 3) ***Analysis of factors affecting the degree of development of human resources for the elderly***

This section uses the SHAP model to analyze the prediction results and explore the factors influencing the degree of development of human resources for the elderly.

(1) Importance analysis

The importance ranking of the factors based on the SHAP value is shown in Figure 4, in which the economic support given by parents to their children and the economic support given by children to their parents are represented by economic support 1 and economic support 2, respectively. It can be seen that among the many factors affecting the degree of human resource development of the urban elderly, the top 5 factors in terms of importance are pension income, education level, age, intergenerational care, and gender. From the comprehensive perspective of “human-economy-health-education-security”, it highlights the centrality of “human” factors in determining the degree of human resources development of the elderly, indicating that individual behavioral choices and the implementation of social security measures play a crucial role in the degree of human resources development. This suggests that individual behavioral choices and the implementation of social security measures play a crucial role in the degree of human resource development. This emphasizes the importance of strengthening education and social protection for older persons in the design of human resources development pathways for urban older persons.

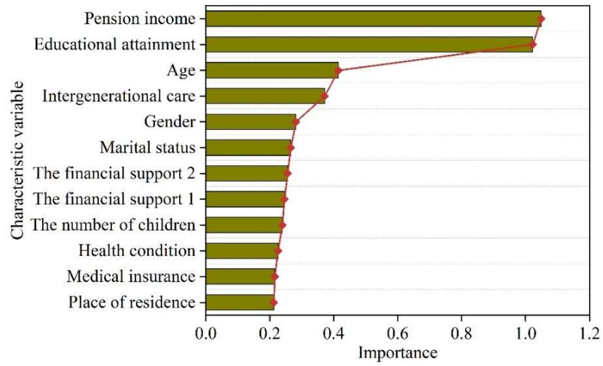


Figure 4: Ranking of the importance of SHAP values

(2) Main effect analysis

The main effects of different factors on the degree of development of human resources for the elderly are shown in Figure 5, where the color scale from bottom to top indicates that the eigenvalues are from low to high. Among the top 5 factors in terms of importance, high pension income, higher education, lower age, and the need for intergenerational care have a higher degree of development of older people's strength resources, and women have a lower degree of development of older people's strength resources. In addition, some of the samples had positive SHAP values for the gender variable, suggesting a possible complex nonlinear relationship.

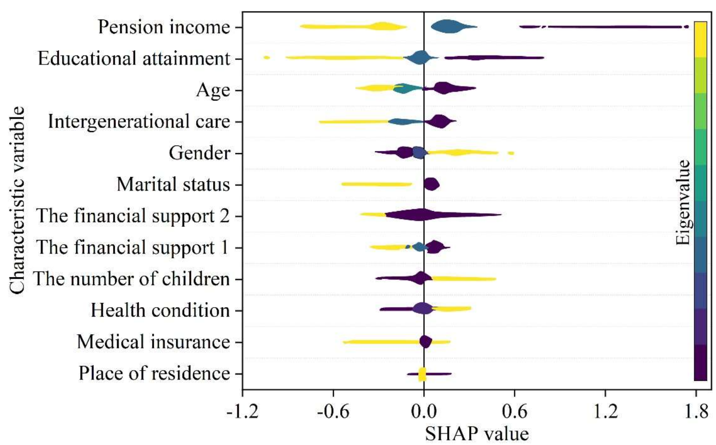


Figure 5: Analysis of factor main effects based on SHAP values

(3) Interaction effect analysis

Based on the SHAP value, we analyze the factor interaction effect and the effect of interaction effect on the dependent variable. The results show that the education level, place of residence and pension income of urban elderly are positively correlated, the higher the education level, the higher the economic level of the city of residence, the higher the pension income, and the higher the degree of development of elderly human resources. At the same time, those with education level lower than “high school”, whose financial burden of intergenerational care is less than 2,000 RMB/month, and whose health condition is poorer, have a lower degree of development of the elderly's human resources. Education level and age are negatively related to health status, and low education level will reduce the economic income of the elderly, which indirectly affects the health status of the elderly. The higher the age, the poorer the health status of the elderly. In addition, there is a non-linear relationship between gender and the degree of human resources development of the elderly, some men and women have a higher degree of human resources development of the elderly, and the degree of human resources development of the elderly women is higher than that of men.

IV. Optimization of the path of human resources development for the urban elderly at an early age

Based on the results of the previous experiments, this paper designs an optimization path for the development of manpower resources for the urban underage elderly. It mainly includes the following contents:

(1) Promote the concept of re-employment among the elderly in the lower age group

Due to the inherent concepts, some people are still psychologically resistant to the development of the younger elderly manpower resources, which requires the government to strengthen the publicity and education, organized in various communities about the development of the younger elderly manpower resources publicity lectures, small steps slowly, gradually in place, slowly break the stereotypes of the elderly. At the same time, reforms should also be made to the educational institutions and curricula for the elderly, including the reform of the existing universities for the elderly, so that they can shift from leisure and recreation programs to vocational and skill-based programs. Can also establish a professional vocational education for the elderly university, continue to further study the vocational skills. Or colleges and universities can set up vocational education colleges for the elderly, which can be recognized as national academic qualifications. Utilize all possible resources to cover vocational education for the elderly nationwide, and promote vocational education for the elderly to become a social norm.

(2) Industry-academia cooperation and market-oriented vocational education for the elderly

Developing the manpower resources of the elderly through vocational education for the elderly is an effective “talent reserve mechanism”, which provides to a large extent the training content necessary for the participation of the elderly in society, subjectively unblocks the re-employment and entrepreneurial channels of the elderly, and promotes their “post-vocational development”, thus making the vocational education for the elderly become a social norm. In this process, there is no doubt about the leading role of the government, but it is difficult to encourage the enthusiasm of the elderly people by relying on the government alone. Enterprises should also be extensively involved in vocational education for the elderly, so as to gradually form a diversified situation in terms of investment and main body. In vocational training, the government can entrust social and economic organizations to be responsible for, and the implementation of tax exemptions or subsidies and other preferential policies, to realize the cooperation between the industry and the university, the combination of work and study. This “school-enterprise” model will enable the supply of low-age elderly talent to be closely aligned with market demand.

(3) Improve the legal system to provide institutional guarantee for the re-employment of the elderly.

Developing the human resources of the under-aged elderly is a strong policy project, and it is necessary to solve the problems of income welfare, competition incentives, age discrimination and other issues encountered by the under-aged elderly in the process of re-employment through the formulation of relevant policies and regulations. On the one hand, the relevant departments should speed up the introduction of laws and regulations to protect the re-employment of the elderly, such as the Regulations on Employment Protection for the Elderly, and propose specific re-employment policies to meet the needs of the younger elderly, so as to provide them with a good background for the general policy. On the other hand, reforming the corporate retirement system, improving the rehiring system, protecting the rights of retired rehires, and enacting laws and regulations such as the Act on Employment Stabilization for the Elderly. Encourage enterprises to design jobs suitable for the elderly, develop job careers for the elderly, and consider the promotion of re-employment for the under-aged elderly as a government project.

(4) Establishment of a national system for the development of human resources for the elderly

Establish a “Population Aging Countermeasures Committee” comprised of the heads of major ministerial departments and ministries, such as the Ministry of Human Resources and Social Security, the Ministry of Health and Family Planning, the Ministry of Education, the Ministry of Finance, and other experts in the field of population aging, to formulate a national-level policy on the development of manpower resources for the underage elderly, and to set up a database of underage elderly talent, At the same time, it establishes employment guidance centers for the under-aged elderly, improves the market for the elderly, and establishes an association for the protection of the rights and interests of the elderly in re-employment, etc., and builds a business cooperation network in conjunction with the local government and economic organizations to provide information on various jobs, and straightens out the relationship of affiliation of the elderly institutions, which are presently run by many different departments under different names, in order to promote re-employment of the under-aged elderly and to turn the spotty and dispersed development into a unified and organized development. (c) Promoting the re-employment of the elderly at an early age, and shifting from piecemeal and scattered development to unified and organized development.

V. Conclusion

Based on COM-B behavioral analysis model, this study constructed a theoretical analysis framework for the development of urban elderly manpower resources, and carried out empirical analysis through SMOTE-XGBoost model and SHAP global interpretable model. The study shows that the SMOTE algorithm effectively solves the data imbalance problem, and the prediction accuracy of the combined XGBoost model reaches 95.1%, indicating that the model has high accuracy.The analysis of SHAP values shows that among the main factors affecting the development of human resources for urban elderly people, pension income, education level, age, intergenerational care and gender rank among the top five. The data show that education level is significantly positively correlated with the place of residence, and that those with education level lower than “high school”, those with financial burden of intergenerational caregiving lower than 2,000 yuan/month, and those with poorer health conditions have lower level of development of strength resources. In addition, the gender factor showed a non-linear relationship, and in some samples, the degree of human resource development of the elderly was higher for women than for men.

Based on the above findings, this study proposes four optimization paths: promoting the concept of re-employment among the younger elderly, promoting the transformation of vocational education for the elderly from leisure and recreation to vocational skills; industry-academia cooperation, and realizing the “school-enterprise” model so that the supply of talent for the elderly can be closely aligned with the market demand; perfecting the “Regulations on the Employment Protection for the Elderly” and the “Law on Employment Stability of the Older Adults”, and other laws; and setting up a national system for developing human resources for the elderly, and establishing a national human resources development system. (c) Establishing a national system for the development of human resources for the elderly, and setting up a committee on countermeasures against population ageing to formulate a national policy for the development of human resources for the elderly.

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