A Novel Modelling Scheme to Assess the Role of Punitive Damages in Copyright Disputes to Promote Intellectual Property Laws

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***Abstract* — To improve the rationality of punitive compensation, we propose a solution for dynamic planning of punitive compensation based on an evaluation model for the maximum deviation. First, we build the evaluation model to combine the whole value of life oriented by punitive compensation and containing life material value, spiritual value, basic value of life and life support value. Secondly, we design a solution for dynamic planning based on the combined evaluation model of the maximum deviation. Finally, we verify the effectiveness of the whole design scheme through case analysis, which can be used to guide the actual work.**

Keywords - maximum deviation; combination elevation; punitive compensation; dynamic planning; case analysis

I. INTRODUCTION

China has established a compensation system for spiritual damages, which applies to the spiritual damages suffered by the victim and his relatives to a certain extent, i.e. the relief might be given. However, when the infringer maliciously violates the rights and interests of the victim with extreme means, the punitive compensation shall be applied, so that the full relief could be given for the spiritual damages suffered by the victim and whose extent is greater than that under general negligence. According to *Several Problem Explanations of the Supreme People's Court on Determination of Responsibilities for Spiritual Damages of Civil Infringement*, the punitive compensation system itself is suitable for aggravated liability for damages with subjective malice and mean tricks. What is to be compensated is the spiritual damage impossibly remedied under general compensation when the infringement action is maliciously taken by the infringer with extreme means. American scholars hold the opinion that the relief provided by traditional liability for general tort is insufficient under extreme and serious infringement on personal rights and interests, and the damages suffered by the victim and difficultly measured by money are mitigated only with money, which is different from the "original state" before infringement of rights in the view of mitigation and neither objectively makes the painful memory hurting the victim and relevant personnel erased nor makes such memory faded. Therefore, there is a crack caused between the target of remedy of damage and the relief provided by laws.

In recent years, national scholars have paid close attention to the life value and its evaluation. Huang Wanhua and Cheng Qizhi (2011) considered that "the value of human life is the unity of utility value and humanity value of human life; the utility value is the unity of social value and self-value, material value and spiritual value" [5]. Cheng Qizhi (2012) has established the evaluation system of life value from three levels of family, enterprise and the country based on two-dimensional attribute of "value creation" and "value support" [6]. Li Bensen (2011) evaluated the life value in legal compensation via willingness-to-pay method and proposed the principle that the life compensation shall reflect classification difference and special difference complementary, the unity of sufficient protection on life, strict sanction and effective prevention on infringement of life and the unity of fairness of laws and efficiency of compensation.

When the life value is evaluated with cost method and income method, the evaluation value is frequently low, and the life value could not be sufficiently reflected. When the life value is evaluated with market method, a certain aspect of safety precaution, value orientation or contribution ability, etc. of the person is taken as reference price, and for different reference, personal difference of living condition and uncertainty of future state, constant change of people's value and other factors, the difference of evaluation value of life value is great or even dozens of times. Actually, a relatively accurate and reliable evaluation value of life value is required, which is taken as both basis maintaining life value and dignity and punishment and prevention against life accident.

II. EVALUATION MODEL OF THE WHOLE VALUE OF LIFE ORIENTED BY PUNITIVE COMPENSATION

According to the evaluation concept of the whole value of life oriented by punitive compensation, establish the evaluation model of the whole value of life oriented by punitive compensation. Specific elevations are as follows:

1. Life material value (VM): the economic value of human lies in constant creation of material wealth for themselves and the society. Life material value reflects the anticipation of material wealth created in the future from now on, which is divided into personal material value and social material value.

2. Spiritual value (VS): the spiritual value mainly considers the loss of cost paid, future support and supporting liability of the victim as well as the compensation for spiritual damage of his closest person other than evaluation of spiritual wealth value created by people, is evaluated in the three aspects of supporting cost, family liability and spiritual loss by taking the material value as the foundation.

3. Basic value of life (VB): regardless of whether the value is created, how many values have been created, age, profession and position, the people have the existence value, and the rights and interests of people are not allowed to be violated. With life existence, the people themselves have value, and it is reflected with basic value of life, which indicates the most basic right and value owned by people, and the basic value of life obtained by the victim is taken as punitive compensation. Based on the equality before the law, the personal factors have no influence in the same country, and the basic value of life shall be equal. In the view of material possession, inheritance, handling and earnings, the value created by people forms state wealth, collectivity wealth and household wealth. Ownership of stated wealth belongs to national people, and earnings are owned by national people. Each citizen has right to share stated-owned property created by people in the past. Household wealth is owned, governed, inherited by family member or special person, and it is generally proper to use the ability of value creation of people within a certain period and the general level of current stated-owned wealth accumulated to reflect the basic value of life. It is expressed as gross national income (GNI) and state wealth per capita within basic year.

4. Support value of life (VE): safety is the most basic requirement of people, and safeguarding the life safety is the primary liability of all organizations. The victim obtains the punitive compensation of support value of life to promote safety input and prevent and resolve safety accident risk and social contradictions. Support value of life is reflected in aspects, including that: firstly, if the safety production input is lower than the standard specified in *Management Method for Fee Drawing and Use of Safety Production of Enterprise* or the use management is improper or fails to meet standard of safety production, the responsible party shall take the amount in the part without sufficient input as compensation to the victim; secondly, based on *Clauses for Liability Insurance of Safety Production*, the insurance amount of safety liability stipulated is taken as the demand limit of the market for value support of people. To better reflect the value, the high insurance amount shall be selected. When evaluation, the support value of life is equal to the sum between sharing amount of the responsible party under deficit of safety input in recent five years and insurance amount of high safety liability stipulated in *Clauses for Liability Insurance of Safety Production*.

III. COMBINATION EVALUATION MODEL OF THE MAXIMUM DEVIATION

A. *Index Description of Multi-Attribute Decision-Making*

It is assumed that *m* object(s) need(s) to be evaluated in multi-attribute decision-making of hospital service system, and the object set is $S=\{S_1,S_2,\cdots,S_m\}$; each object has c attribute(s), and set attribute index set as $G=\{G_1,G_2,\cdots,G_c\}$. Set attribute value of S_i of the i[th] object on G_j of the j[th] object as y_{ij} . $i=1,2,\cdots,m$, $j=1,2,\cdots,c$ and $Y=(y_{ij})_{m\times c}$ are attribute matrix.

As for combination evaluation, the evaluation values of several single evaluation methods need to be combined, and there is a problem on selection of single evaluation method existing. For different scientific methods have different attributes and the range of application is also different, the evaluation conclusions of some single evaluation methods have comparable basis and are possibly combined, while some methods are not. Therefore, select the single evaluation methods with same attribute, and establish method set f which has n evaluation methods, and then the evaluation method set $f=\{f_1,f_2,\cdots,f_n\}$.

Use single evaluation method in method set f for evaluation of each object, and obtain evaluation result matrix *F*. the evaluation value of the object S_i in evaluation method f_j is y_{ij} , $F=(f_{ij})_{m\times n}$, $i=1,2,\cdots,m$ and $j=1,2,\cdots,n$.

B. *Combination Model of the Maximum Deviation of Punitive Compensation*

Combination evaluation method based on the maximum deviation is to establish the model with the concept where the distance of result values under different methods could be the maximum, so as to obtain the weight of each singe evaluation method; combine evaluation values of single evaluation methods on all evaluation objects based on weights, and finally obtain the combination evaluation value. The distance obtained of final result values of objects are relatively larger for sequence.

Assume that the weight vector of single evaluation method is $W=\{w_1,w_2,\cdots,w_n\}^T$, then the combination evaluation value of the object S_i is:

$$F_i=w_1f_{i1}+w_2f_{i2}+\cdots+w_nf_{in} \tag{1}$$

Assume that d_{ijt} is the deviation between the object S_i and the object S_t in single evaluation method f_j , where $t=1,2,\cdots,m$, and d_{ijt} could be expressed as:

$$d_{ijt}=|f_{ij}-f_{tj}| \tag{2}$$

In multi-attribute decision-making, if the difference of evaluation values of the j th single evaluation method f_j on all decision-making objects is small, the weight in such evaluation method is small. Conversely, if the different of evaluation values of f_j on all decision-making objects is great, the evaluation value will have great effect on sequence of decision-making object, and the weight is great. The basic concept of selection of weight vector of combination evaluation method is to make the total deviation of all n methods on m decision-making objects maximum, which both guarantees great deviation of result values for distance extension and sequence and has advantages of combination evaluation to overcome difference of evaluation conclusions of several evaluation methods in application for different mechanisms of single methods.

$$d_{it} = \sum_{j=1}^{n} w_j \mid f_{ij} - f_{tj} \mid \tag{3}$$

Establish the model, and under combination evaluation method, the total deviation of all evaluation objects is:

$$D = \sum_{i=l}^{m}\sum_{c=l}^{m}\sum_{j=l}^{n} w_j \mid f_{ij} - f_{tj} \mid \tag{4}$$

As for acquisition of weight vector $W = (w_1, w_2, \cdots w_n)^T$ of combination evaluation, it is necessarily for the total deviation of all evaluation objects to be the maximum under combination evaluation method, and then, there is the model:

$$\max D = \sum_{i=1}^{m}\sum_{t=1}^{m}\sum_{j=1}^{n} w_j \left| f_{ij} - f_{tj} \right|, \quad s.t. \sum_{j=1}^{n} W_j^2 = 1, \quad w_j > 0, j = 1, 2, \cdots, n \tag{5}$$

IV. DEEP LEARNING OF NETWORK OF DYNAMIC PLANNING

A. Deep Neural Networks

Deep neural networks (**Deep neural networks, DNN)** are the basic structure of deep network learning code, which mainly performs feature extraction and dimension compression process. DNNs realizes the network structure improvement based on addition of hidden layer between input layer and output layer of traditional neural network. It is required that the number of node in hidden layer is smaller than that in input layer (encoder) and output layer (decoder). With training process of network parameters, the mapping of input and output with common character of learning model could be established. Compression method of data dimension mainly includes principal component analysis (PCA); however, the learning method of deep coding from the experiment of literature [13] is better than that of PCA coding.

To effectively learn and train DNNs network, design non-supervision learning and training method to realize the non-supervision layer-by-layer fine adjustment of greedy parameters, so that the partial undesirability of extreme value in deep training model is solved. Its procedure is different from that of the above. Use second-order parameter optimization form for Hessian matrix solution, so as to realize the simplification of training process of deep network learning and training. DNNs structure is shown as Fig.1.

Fig.1 shows the slight difference between DNNs structure and traditional neural network structure. Here, at least one layer of hidden structure is added for learning, and such structure could obviously improve the performance of recognition algorithm of network structure.

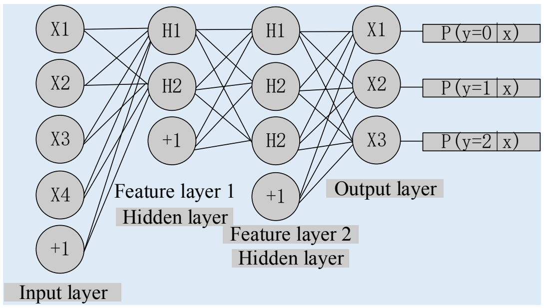

Figure 1. DNNs structure.

B. Heuristic DNNs Dynamic Planning

Before presentation of design of damping controller based on HDP, firstly and briefly introduce heuristic dynamic planning (DNNs-HDP) algorithm based on objective expression. DNNs-HDP is the new reinforcement learning mechanism evolved from adaptive dynamic planning (ADP) method in recent years. It needs three functional approaching networks, including target network, critical network and action network, all of which adopt deep neural networks for establishment. Learning function of evaluation network is similar to cost function of Bellman equation; action network learning will generate control strategy to reduce the approximate cost of evaluation network to the greatest extent, while the target network provides an internal reinforcement signal of adaption. Specifically, the definition of functional cost function is shown as follows:

$$J[x(i), i] = \sum_{t=i}^{\infty} \gamma^{t-i} U[x(t), u(t), i] \tag{6}$$

Where, $x(t)$ is the state vector of the system; $u(t)$ is control law; U is utility function, and γ is discount factor. In the paper, all three networks realize three-layer nonlinear structure with a neural network of hidden layer. However, learning rule also could be extended to random functional

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approximation by applying appropriate counter-propagation rule.

Step1： (target network training) the performance cost of the system could be expressed with a compact form. Target of dynamic planning is to select control sequence $u(t)$ for minimization of cost function J . The form is shown as follows:

$$J^*(x(t)) = \min_{u(t)}\{U(x(t),u(t)) + \gamma J^*(x(t+1))\} \tag{7}$$

Based on this structure, J could be estimated via the following formula:

$$\|E_h\| = \frac{1}{2}\sum_t [J(t) - r(t) - \alpha J(t+1)] \tag{8}$$

When t of all moments has $E_h = 0$, obtain:

$$J(t) = r(t) + \alpha J(t+1) \tag{9}$$

Obtain the following formula through gradual iteration:

$$J(t-1) = r(t-1) + \alpha J(t) \tag{10}$$

Form of the minimization of target function in target network is:

$$\begin{cases} e_g(t) = \alpha J(t) - [J(t-1) - r(t-1)] \\ E_g(t) = \frac{1}{2}e_g^2(t) \end{cases} \tag{11}$$

Counter-propagation path of high-level concept is:

$$\frac{\partial E_g(t)}{\partial \omega_g(t)} = \frac{\partial E_g(t)}{\partial J(t)}\frac{\partial J(t)}{\partial s(t)}\frac{\partial s(t)}{\partial \omega_g(t)} \tag{12}$$

As for deep neural network used, the connection weights from input layer to hidden layer, hidden layer to output layer are adjusted as follows:

$$\begin{cases} \Delta\omega_{g_i}^{(2)} = \eta_g(t)\left[-\frac{\partial E_g(t)}{\partial \omega_{g_i}^{(2)}(t)}\right] \\ \omega_{g_{i,j}}^{(1)} = \eta_g(t)\left[-\frac{\partial E_g(t)}{\partial \omega_{g_i}^{(1)}(t)}\right] \end{cases} \tag{13}$$

Step 2: (evaluation network training) once the target network outputs signal, it will be considered as the input of evaluation network, and used for definition of error function to realize evaluation network parameter adjustment, and the form is shown as follows:

$$\begin{cases} e_c(t) = \alpha J(t) - [J(t-1) - s(t)] \\ E_c(t) = \frac{1}{2}e_c^2(t) \end{cases} \tag{14}$$

Counter-propagation path is:

$$\frac{\partial E_c(t)}{\partial \omega_c(t)} = \frac{\partial E_c(t)}{\partial J(t)}\frac{\partial J(t)}{\partial \omega_c(t)} \tag{15}$$

Weight of evaluation network on input of hidden layer from hidden layer to output layer is adjusted as follows:

$$\begin{cases} \Delta\omega_{c_i}^{(2)} = \eta_c(t)\left[-\frac{\partial E_c(t)}{\partial \omega_{c_i}^{(2)}(t)}\right] \\ \Delta\omega_{c_{i,j}}^{(1)} = \eta_c(t)\left[-\frac{\partial E_c(t)}{\partial \omega_{c_{i,j}}^{(1)}(t)}\right] \end{cases} \tag{16}$$

Step 3: (action network training) adaptive adjustment of network behavior in such structure is similar to typical ADP backward error propagation method to make the output U_c of evaluation network approximate to final target J . When U_c signal is reinforced, it is indicated that the network behavior is effective. Therefore, the error adjustment function of network behavior parameter is shown as follows:

$$e_a(t) = J(t) - U_c(t),\ E_a(t) = \frac{1}{2}e_a^2(t) \tag{17}$$

For action network is connected with target network and evaluation network, the counter-propagation path form is shown as follows:

$$\begin{cases} \frac{\partial E_a(t)}{\partial \omega_a(t)} = P_{a,c}(t) + P_{a,g}(t) \\ P_{a,c}(t) = \frac{\partial E_a(t)}{\partial J(t)}\frac{\partial J(t)}{\partial u(t)}\frac{\partial u(t)}{\partial \omega_a(t)} \\ P_{a,g}(t) = \frac{\partial E_a(t)}{\partial J(t)}\frac{\partial J(t)}{\partial s(t)}\frac{\partial s(t)}{\partial u(t)}\frac{\partial u(t)}{\partial \omega_a(t)} \end{cases} \tag{18}$$

In action network, the weight on input of hidden layer from hidden layer to output layer is adjusted as follows:

$$\begin{cases} \Delta\omega_{a_i}^{(2)} = \eta_a(t)\left[-\frac{\partial E_a(t)}{\partial \omega_{a_i}^{(2)}(t)}\right] \\ \Delta\omega_{a_{i,j}}^{(1)} = \eta_a(t)\left[-\frac{\partial E_a(t)}{\partial \omega_{a_{i,j}}^{(1)}(t)}\right] \end{cases} \tag{19}$$

V. CASE OF EVALUATION ON THE WHOLE VALUE OF LIFE ORIENTED BY PUNITIVE COMPENSATION

As for case of evaluation on the whole value of life, select middle value of three age phases of life cycle, and for other data, select the mean value. In 2013, the total population in Chinese mainland was 1.36072 billion at the end of year; the gross national income (GNI) was RMB 56.7139 trillion; per capital GNI was about RMB 41,697; GDP was 56.8845 trillion; per capital GDP was about RMB 41,805; the owner's equity of stated-owned business organization was about 330 trillion; rural per capita net income was RMB 8,896; urban per capita disposable income was RMB 26,955; weighted per capita income of national resident was about RMB 18,311; the annual per capital income of ordinary worker was about RMB 32,878, and the average life span is 75 years old. Based on the above data, obtain:

Basic value of life:

$$V_B = \frac{330\times10^4}{13.6072} + 41679\times20 = 1076099(\text{RMB})$$

Assume that the safety input of evaluated object meets national provisions of *Management Method for Fee Drawing and Use of Safety Production of Enterprise*, and the support value of life is RMB 600 thousand.

A. Case of Evaluation of the Whole Value of Life before Work

Select 10-year-old child, and per capital supporting cost before work is RMB 30 thousand. Life material value is:

$$V_M = V_{MP} + V_{MS} = 18311\times60\%\times[(\frac{75}{2}-22)+10]+$$

$$(41805-18311)\times[(\frac{75}{2}-22)+10] = 879255(\text{RMB})$$

Spiritual value of life:

$$V_s = V_{St.} + V_{FR} + V_{SM} = 30000\times10+$$

$$(30000\times10+879255.3)\times[1-\frac{75/2-10}{75/2}] = 614468(\text{RMB})$$

The whole value of life:

$$V_L = V_B + V_M + V_s + V_E = 1076099$$

$$+879255+614468+600000 = 3169822(\text{RMB})$$

B. Case of Evaluation of the Whole Value of Life during Work

Select 40-year-old adult, and assume that he is retired when 60 years old; personal income accounts for 40% of family income; the number of family member is four, including his mate, 65-year-old old man or woman, himself and 15-year-old child. By inquiring the life table, the expected survival time of 40-year-old people and 65-year-old people is 37 years and 16.5 years.

Life material value of 40-year-old adult:

$$V_M = V_{MP} + V_{MS} = 32878\times[20+(37-20)\times80\%]+$$

$$(41805-18311)\times[20+(37-20)\times80\%] = 1894099(\text{RMB})$$

Spiritual value of life of 40-year-old adult:

$$V_S = V_{SC} + V_{FR} + V_{SM} = 0 + 32878\times[(22-15)\times20\% + (72-65)$$

$$\times20\% + (81.5-72)\times40\%] + 1894099.2\times40\%\times\left[1-\frac{40-75/2}{75/2}\right] = 1099808(\text{RMB})$$

Whole value of life:

$$V_L = V_B + V_M + V_s + V_E = 1076099$$

$$+1894099+1099808+600000 = 4693715(\text{RMB})$$

C. Case of Evaluation of the Whole Value of Life during Retirement

Select 68-year-old man or woman, and by inquiring the life table, the expected survival time of 65-year-old people is about 11.5 years. The life material value is:

$$V_M = V_{MP} + V_{MS} = 32878\times80\%\times11.5+$$

$$(41805-18311)\times11.5\times80\% = 518622(\text{RMB})$$

Spiritual value of life:

$$V_s = V_{SC} + V_{FR} + V_{SM} = 0+$$

$$518622.4\times1\times[1-\frac{68-75/2}{75/2}] = 96810(\text{RMB})$$

Whole value of life:

$$V_L = V_B + V_M + V_S + V_E = 1076099$$

$$+518622+96810+600000 = 2291531(\text{RMB})$$

VI. CONCLUSION

Mid-value data are selected for the above evaluation of life value, and it can be known that the whole value of life oriented by punitive compensation before work, during work and during retirement is generally RMB 3,169,822, RMB 4,693,715 and RMB 2,291,531, and the whole values of life of most people belonging to these phases are close to these evaluation values, and these results are higher than evaluation values with cost method and income method, but lower than evaluation values with market method. Comprehensively, such values have representative level, and perfectly reflect the life value. Chinese latest standard on compensation of life is "20 times of urban per capita disposable income of China in the previous year". The urban per capita disposable income of China was RMB 24,565 in 2012, and the standard on compensation of life was 491,300 in 2013. In three phases, the general level of the whole value of life is 15.50%, 10.47% and 21.44%, and the maximum difference is RMB 4.2 million with nearly 9 times. The whole value of life could better maintain rights and interests of life. Among 69,434 Chinese people dying from production safety accident in 2013, most of people are workers in working phase. If 40-year-old adult is taken as reference, the total value of the whole value of life is RMB 325.9 billion, which is higher than total value of current standard on compensation of life of RMB 291.8 billion.With the addition of non-profit foundation of local safety of RMB 116.4 billion in punitive damages, the total amount of punitive damages is RMB 442.3 billion. The whole value of life oriented by punitiveness may better safeguard the life value of the victim, greatly increase expected amount of loss for safety accident of potential inflicter and promote the reduction of possibility of safety accident, which is close to tolerable level of the society.

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