Research on Information Security Human Resource Innovation Management Based on Deep Learning Algorithms

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Abstract:

In order to improve the effect of enterprise human resources training, this paper combines deep learning technology to construct an innovative system of enterprise human resources training. Aiming at the linear human resource training information diffusion equation, a new numerical calculation method is constructed by combining the point interpolation meshless algorithm with the characteristic line method. Afterwards, this paper presents the algorithm derivation for the one-dimensional and two-dimensional problems of the linear human resource training diffusion information equation. Finally, this paper discusses and proves the unique existence of solutions to the one-dimensional linear HR training diffusion equation. The simulation analysis results show that the enterprise human resources training system based on deep learning proposed in this paper can effectively improve the effect of human resources training.

Keywords: deep learning; enterprise; human resources; training innovation; Information Security

1 INTRODUCTION

In the development of an enterprise, the main factors affecting the development speed and internal operation of the enterprise are the knowledge level, comprehensive quality and overall operation level of modern enterprise employees. Therefore, strengthening the management level of enterprise human resources can enable enterprises to move forward steadily in the future development and enhance the competitiveness of enterprises in the future development [1]. Moreover, enterprise human resources training is not only to improve the competitiveness of the enterprise, but also to reflect the personal value of employees in the future development of employees. In the construction of enterprises, manpower is the main factor to promote production, and it is the basis for enterprises to survive and develop in the future economic market [2].

The training of human resources in enterprise construction can directly improve the comprehensive quality of employees, and it is also the main channel for the improvement of enterprise management. The level of enterprise management directly affects the production quality and production efficiency of enterprise products, and even directly affects the success or failure of the entire company's operating mechanism. The root cause of all these factors is that people are the executors of production development in enterprise development Managers, operators of the whole mechanism reform, and people determine the development process of the enterprise in this process [3]. The training of talents in the development of enterprises not only affects the competitiveness of enterprises in the whole economic market, but also relates to the internal management ability of enterprises. The future development, competitiveness and self survival ability of enterprises are all important ways for enterprises to maintain core competitiveness in the economic market. In terms of enterprise management, we should strengthen the training of human resources, apply advanced training models to guide the training of internal personnel, integrate the development, training and use of internal human resources, serve the future development of the enterprise in many ways, improve the quality of enterprise talents, and enable the rational allocation of enterprise human resources, so as to achieve the sustainable development of the enterprise in the future economic market [4].

With the continuous development of the social and economic market, emerging industries are emerging, followed by the emergence of new business forms, new business models, and new industrial chains, in which the production and operation methods of enterprises have also undergone significant changes. The production mode of automation, mechanization and informatization makes enterprises have higher and higher requirements for overall production quality, quality and ability. It is very important to do a good job in training enterprise talents from these aspects [5]. Enterprise human resource training is the most important means to achieve the goal of modern enterprise development, and also an important factor for solid enterprise development. The in-depth reform of the enterprise has changed the operation, management and personnel, which makes the enterprise pursue higher goals when conducting human resources training [6].

Before conducting human resources training, enterprises should check the employees inside the enterprise, understand their personal development status, conduct professional assessment of the industry's development normality and future trend, and train key employees in the latest technology, so that they can update the management methods of enterprise managers in a timely manner by understanding new industry theoretical knowledge, so that they can keep pace with the development of the times, Understand the latest management concept in the whole industry, so that enterprise employees can understand the future development direction of the industry, and through their own training, they can constantly learn to master new knowledge and skills, adapt to the development needs of the future industry, help enterprises instill new production concepts, promote enterprise productivity, and achieve the common development of enterprises and individuals [7].

Through grasping the direction of enterprise industry development in the new era, we can draw a conclusion that comprehensive training for enterprise employees should pay more attention to the development needs of the times. Therefore, the staff training of enterprise staff can not only be achieved through professional courses, but also through the use of new working methods in work, so that the enterprise and staff will not be eliminated in the era of rapid development [8]. However, the operation of the new work concept requires long-term effective vocational training. The development of new work requirements of the enterprise means that employees should master the work skills of this position. The enterprise should set new training objectives in the future economic development. The overall work process should be implemented in the rational development and utilization of human resources. Therefore, comprehensive management should be carried out in the enterprise staff training, Realize the reasonable application of the whole training process [9].

During the development and production of enterprises, the safety of employees is the goal of economic stability of enterprises. It is not only related to the stability of the life of enterprise employees, but also related to the long-term stability of national construction. Therefore, enterprise human resources training should be planned, developed and targeted, effectively carry out the training work, complete the goal of talent training, make talent training close to the needs of enterprise production and operation and the improvement of employees' comprehensive quality, achieve the long-term strategic goal of cultivating sustainable development for the enterprise, comprehensively improve the comprehensive quality and professional work skills of enterprise employees, and create a batch of thoughtful, innovative The high-quality talent team will enable the enterprise to move forward steadily in the future economic development [10].

The managers of enterprise staff training should strengthen the planning for the future development of the enterprise, understand the self-development needs of enterprise staff, formulate long-term goals with development strategies and development strategies, realize the modeling and institutionalization of human resource training, and make the human resource training of the entire enterprise traceable and steady. Before training, it is necessary to conduct a comprehensive investigation on the number, technology, job requirements, basic education and other information of the staff to be trained, and then comprehensively sort out the information to formulate a long-term and targeted training management plan, as well as the time, site arrangement, course content, practical application, etc. of personnel training [11]. Encourage learning for each trainee, so that they can actively participate in the practice of enterprise construction, better master professional skills and understand the application scope of the learned professional knowledge through practical application. To institutionalize human resources, each link of training should be concretely and operationally arranged. A sound mechanism needs to be implemented in the content and time of training courses. Each link of this process should ensure the future development of the enterprise [12]. In the practical arrangement of enterprise trainers, we should summarize the work experience of industry leading talents or highly qualified and competent experts, and formulate a reasonable assessment plan in the later stage of the training, so that the training can be completed with quality and quantity guaranteed [13].

When conducting professional training for on-the-job employees, we should consider the training efficiency of employees and the direction of development in the new era, improve the previous training methods and contents, enhance their interest in learning, make the training process easier and more interesting, and promote their acceptance of knowledge and mastery of professional skills. The training courses with rich contents, various forms and high quality shall be adopted for guidance, so as to promote employees' active learning and realize the value of training [14]. When conducting human resources training for enterprise employees, the course content is not only for theoretical education and supplement, but also for problems that may be encountered in work. From these problems, guide employees to find good solutions through learning and obtain new solutions. The course content can also analyze the classic cases in the enterprise, so that the staff can find the content direction through specific case analysis. In this process, the staff can also understand the development history of the enterprise, master the future development direction of the enterprise, and consciously summarize the experience and lessons from the cases [15]. The training of front-line employees should be implemented in production skills. The trainers should implement this process in the teaching of methods and practical operation drills. Only when the two are organically combined, can employees achieve standardization of production quality and operation methods in production, so as to achieve better training effects, achieve the integration of the entire training process, and achieve a systematic process from theoretical guidance to practical application [16].

In the context of the development of the new era, the training curriculum model should be closely combined with the training content. In the practice of the curriculum, we should dare to innovate, create new teaching models, explore new training ideas, and enable the training curriculum to achieve multi-level and multi angle development. The central goal of the training course must be to focus on the employees, take the future development of the enterprise as the main guiding goal of the course content, and the course content should closely focus on the concerns of the employees and understand the real thoughts of the employees [17].

This paper combines deep learning technology to build an innovative system of enterprise human resources training, improve the effect of enterprise human resources training, and provide a reference for the improvement of the comprehensive quality of enterprise personnel.

2 POINT INTERPOLATION MESHLESS METHOD FOR LINEAR TRAINING INFORMATION EQUATION

2.1 Point interpolation algorithm for 1D training information equation

This paper considers the initial boundary value problem of the one-dimensional training information equation.

$$\begin{cases} c(x,t)\dfrac{\partial u}{\partial t}+b(x,t)\dfrac{\partial u}{\partial x}-\dfrac{\partial}{\partial x}\left(a(x,t)\dfrac{\partial u}{\partial x}\right)=f(x,t), \quad (x,t)\in(0,L)\times(0,T) & (1) \\ u(x,0)=u_0(x), \quad x\in(0,L) & (2) \\ u(0,t)=f_1(t), \quad u(L,t)=f_2(t) \quad t\in(0,T) & (3) \end{cases}$$

Among them, a(x, t), b(x, t), c(x, t), and f(x, t) are independent variable functions, which satisfy $a(x,t)\geq a_0>0, c(x,t)\geq c_0>0$. Next, we will derive its differential format.

In the first step, first we transform formula (1) into the corresponding characteristic-difference scheme.

We set $\psi(x,t)=\sqrt{c^2(x,t)+b^2(x,t)}$, and set the characteristic direction associated with the operator $c(x,t)\dfrac{\partial}{\partial t}+b(x,t)\dfrac{\partial}{\partial x}$ to be $\tau=\left(\dfrac{c(x,t)}{\psi(x,t)},\dfrac{b(x,t)}{\psi(x,t)}\right)$. At this time, the derivative along the direction of τ is:

$$\frac{\partial}{\partial\tau}=\frac{c(x,t)}{\psi(x,t)}\frac{\partial}{\partial t}+\frac{b(x,t)}{\psi(x,t)}\frac{\partial}{\partial x} \quad (4)$$

Therefore, formulas (1) and (3) can be rewritten in the characteristic form:

$$\begin{cases} \psi(x,t)\frac{\partial u}{\partial\tau}-\frac{\partial}{\partial x}\left(a(x,t)\frac{\partial u}{\partial x}\right)=f(x,t), \quad (x,t)\in(0,L)\times(0,T) & (5) \\ u(x,0)=u_0(x), \qquad x\in(0,L) & (6) \\ u(0,t)=f_1(t), \quad u(L,t)=f_2(t) \qquad t\in(0,T) & (7) \end{cases}$$

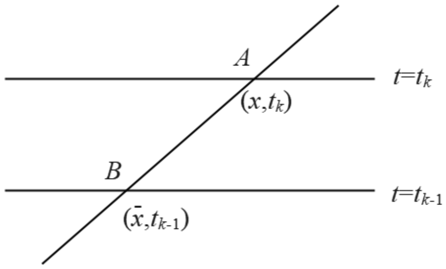


Figure 1 Schematic diagram of discrete along the characteristic line

We take the time step as $\Delta t>0$, and make the grid node $t_k=k\Delta t,(k=0,1,2,\cdots)$ along the time t axis. Then as shown in Figure 1, the coordinates of the intersection point of the characteristic direction starting from (x,t_k) and the straight line $t=t_{k-1}$ are:

$$\bar{x}=x-\frac{b(x,t_k)}{c(x,t_{k-1})}\Delta t \quad (8)$$

The eigendirectional derivative can then be approximated by the following approximate formula.

$$\left(\psi\frac{\partial u}{\partial\tau}\right)^k\approx\psi(x,t_k)\frac{u(x,t_k)-u(\bar{x},t_{k-1})}{\sqrt{(x-\bar{x})^2+(\Delta t)^2}}=c(x,t_k)\frac{u(x,t_k)-u(\hat{x},t_{k-1})}{\Delta t} \quad (9)$$

Among them, $\bar{x}=x-\frac{b(x,t_k)}{c(x,t_{k-1})}\Delta t$. Substitute formula (9) into formula (5), when $t=t_k$, there are:

$$c(x,t_{k-1})\frac{u(x,t_k)-u(\hat{x},t_{k-1})}{\Delta t}-\frac{\partial}{\partial x}\left(a(x,t_{k-1})\frac{\partial u(x,t_{k-1})}{\partial x}\right)=f(x,t_{k-1})+r^k(x) \quad (10)$$

Among them, $r^k(x)$ is the local truncation error caused by the differential discretization of the eigendirection derivative.

The corresponding characteristic difference scheme can be obtained by deforming, sorting out and discarding the local truncation error.

$$u^k=\hat{u}^{k-1}+\frac{\Delta t}{c^{k-1}}\left(\frac{\partial}{\partial x}\left(a^{k-1}\frac{\partial u^{k-1}}{\partial x}\right)+f^{k-1}\right) \quad (11)$$

Among them, $u^k=u(x,t_k),\hat{u}^{k-1}=u(\hat{x},t_{k-1}),c^{k-1}=c(x,t_{k-1}),a^{k-1}=a(x,t_{k-1}),f^{k-1}=f(x,t_{k-1})$.

The second step is to construct an approximation function using point interpolation meshless method.

The construction of the interpolation approximation function over a given temporal layer $t = t_k$ is considered. The solution interval [0, L] is discretized with n nodes $x_i(i = 1,2,\cdots,n)$ (including two boundary points). In this way, the approximate function of the function $u(x,t_k)$ in the region [0, L] can be constructed by the point interpolation method to form the following function representation:

$$v^k(x) = \sum_{i=1}^{n} R_i(x)\alpha_i^k + \sum_{j=1}^{m} P_j(x)\beta_j^k \quad (12)$$

Among them, $R_i(x)$ is the radial basis function, α_i^k is the coefficient of $R_i(x)$, to be determined. $P_j(x)$ is the monomial basis function defined on the plane rectangular coordinate system, β_j^k is the coefficient of $P_j(x)$, to be determined. n is the number of nodes in the influence domain of node x, m is the number of functions of the monomial basis, usually m<<n.

The third step is to establish the feature difference-point interpolation calculation format of (1).

Substituting formula (12) into formula system (11), we get:

$$v^k(x) = \bar{v}^{k-1}(x) + \frac{\Delta t}{c^{k-1}(x)}\left\{\sum_{j=1}^{n}\alpha_j^{k-1}\left[\frac{d}{dx}\left(a^{k-1}(x)\frac{dR_j(x)}{dx}\right)\right] + \sum_{j=1}^{m}\beta_j^{k-1}\left[\frac{d}{dx}\left(a^{k-1}(x)\frac{dP_j(x)}{dx}\right)\right] + f^{k-1}(x)\right\} \quad (13)$$

We substitute the node $x_i(i = 1,2,\cdots,n)$ information into formulas (13), (2), and (3) in turn, we get:

$$\begin{cases} v_i^k = \bar{v}_i^{k-1} + \dfrac{\Delta t}{c_i^{k-1}}\left\{\sum_{j=1}^{n}\alpha_j^{k-1}\left[\dfrac{d}{dx}\left(a(x,t_{k-1})\dfrac{dR_j(x)}{dx}\right)\right]_{v=x_i} + \sum_{j=1}^{m}\beta_j^{k-1}\left[\dfrac{d}{dx}\left(a(x,t_{k-1})\dfrac{dP_j(x)}{dx}\right)\right]_{k=x_i} + f_i^{k-1}\right\}, & (14) \\ \qquad 2 \le i \le n, & \\ v_i^0 = u_0(x_i), 1 \le i \le n, & (15) \\ v_1^k = f_1(t_k), v_n^k = f_2(t_k) \qquad k = 1,2,\cdots & (16) \end{cases}$$

Among them, v_i^k represents the value of u(x) at time t_k point x_i, $\hat{v}_i^{k-1} = v(\bar{x}_i, t_{k-1}), \alpha^k = S_a v^k, \beta^k = S_b v^k, S_a$ can be obtained from (42), (40), f_i^k represents the value of f(x,t) at point x_i at time t_k.

Formulas (14)~(16) are the required feature difference-point interpolation calculation format.

Knowing the initial value v_i^0 from equation (15), substituting them into $\alpha^0 = S_a v^0, \beta^0 = S_b v^0$, we can get α^0, β^0, and calculating $\bar{v}_i^0 = v(\bar{x}_i, t_0)$ at the same time, and then substituting the above results into equation (14) to get v_i^1. Repeating the above steps, $v_i^2, v_i^3 \cdots$ can be obtained in turn, so that the approximate discrete value of the function u=u(x,t) at any time layer $t_k = k\Delta t(k > 0)$ can be obtained.

In order to prove the unique existence of the solution, we first rewrite the calculation format of formula (14) and express it in matrix form. In formula (14), when calculating the correlation term of $t = t_k$, the right end is the correlation term of the time horizon $t = t_{k-1}$, which is obviously known. Substitute the interpolation function (12) into the equation, it can be written in matrix form:

$$\begin{bmatrix} R & P \\ P^T & 0 \end{bmatrix} \begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} G \\ 0 \end{bmatrix} \quad (17)$$

Among them, R is the radial basis function matrix, P is the monomial basis function matrix, and the specific expression is:

$$P = \begin{bmatrix} 1 & x_1 & \dots & x_1^{m-1} \\ 1 & x_2 & \dots & x_2^{m-1} \\ \vdots & \vdots & & \vdots \\ 1 & x_n & \dots & x_n^{m-1} \end{bmatrix} \quad (18)$$

G is a vector composed of the values of the right-hand term when the time horizon $t = t_{k-1}$ in formula (14). Obviously, to prove the unique existence of the solution of the above one-dimensional pair of training information equations by the point interpolation meshless method, it is only necessary to prove the unique existence of the solution of formula (17), that is, to prove the reversibility of $\begin{bmatrix} R & P \\ P^T & 0 \end{bmatrix}$.

Lemma 1: A is a $n \times n$ positive definite symmetric matrix, B is a $n \times m(n > m)$ matrix, and $rank(B) = m$, then $B^{\bullet} AB$ is symmetric.

In order to prove $rank(B) = m$, the row elementary transformation can be performed on B: $B_1 = Q_1 B(Q_1$ is an $n \times n$ invertible matrix), so that the linearly independent group of B_1 is located in the first m rows, and the element values of the last n-m rows are all 0, there are:

$$B^T AB = \left(Q_1^{-1} B_1\right)^T AQ_1^{-1} B_1 = B_1^T \left(Q_1^{-1}\right)^{\bullet} AQ_1^{-1} B_1 = B_1^T \left(\left(Q_1^{-1}\right)^T AQ_1^{-1}\right) B_1 \quad (19)$$

Q_1 is reversible, so $\left(Q_1^{-1}\right)^T A_1^{-1}$ is reversible.

We divide B_1 into blocks: $B_1^T = \begin{bmatrix} B_2 & 0 \end{bmatrix}$, obviously B_2 is a $m \times m$ invertible matrix, and formula (19) can be written in the form of a block matrix:

$$B^T AB = \begin{bmatrix} B_2^T & 0 \end{bmatrix} \begin{bmatrix} A_1 & A_2 \\ A_3 & A_4 \end{bmatrix} \begin{bmatrix} B_2 \\ 0 \end{bmatrix} = B_2^T A_1 B_2$$

A is symmetric positive definite, and its contract matrix $\left(Q_1^{-1}\right)^T AQ_1^{-1}$ is symmetric positive definite, then A_1 is symmetric positive definite, $B_2^T A_1 B_2$ is symmetric positive definite, so $B^{\bullet} AB$ is symmetric positive definite. The proof is complete.

Lemma 2: We assume that the radial basis function R(x) is a positive definite function, then the matrix $R = \left\{R_j\left(x_k\right)\right\}_{N \times N}$ is a symmetric positive definite matrix.

Lemma 3: $T=\begin{bmatrix} A & B \\ 0 & D \end{bmatrix}$, if A,D is invertible, then T is invertible.

The proof is as follows: From $\begin{bmatrix} A & B \\ 0 & D \end{bmatrix}\begin{bmatrix} E_n & -A^{-1}B \\ 0 & E_m \end{bmatrix}=\begin{bmatrix} A & 0 \\ 0 & D \end{bmatrix}$ and $\begin{bmatrix} A & 0 \\ 0 & D \end{bmatrix}^{-1}=\begin{bmatrix} A^{-1} & 0 \\ 0 & D^{-1} \end{bmatrix}$, we know that $T^{-1}=\begin{bmatrix} E_n & -A^{-1}B \\ 0 & E_m \end{bmatrix}\begin{bmatrix} A^{-1} & 0 \\ 0 & D^{-1} \end{bmatrix}=\begin{bmatrix} A^{-1} & -A^{-1}BD^{-1} \\ 0 & D^{-1} \end{bmatrix}$ is reversible. The proof is complete.

Theorem 1: For the one-dimensional pair of training information equations (1) and (3), there is a unique solution to the point-interpolation meshless method that takes the Guass function as the radial basis function.

The proof is as follows: The Guass function has positive definite symmetry. From Lemma 2, it can be known that R is positive definite symmetric, so it is reversible. Elementary transformation of $\begin{bmatrix} R & P \\ P^T & 0 \end{bmatrix}$ is as follows:

$$\begin{bmatrix} E_n & 0 \\ -P^TR^{-1} & E_m \end{bmatrix}\begin{bmatrix} R & P \\ P^T & 0 \end{bmatrix}=\begin{bmatrix} R & P \\ 0 & -P^TR^{-1}P \end{bmatrix}$$

Since the elementary transformation does not change the invertibility of the matrix, the problem is transformed into finding the invertibility of $\begin{bmatrix} R & P \\ 0 & -P^TR^{-1}P \end{bmatrix}$.

Moreover, from Lemma 3, we need to prove the reversibility of $P^TR^{-1}P$. R^{-1} is obviously reversible. It is obvious from formula (18) that the first m rows of P constitute the m-level Vandermonde determinant. Due to the mutual dissimilarity of nodes, it can be known that Yum acts as its largest linearly independent group, so $rank(P)=m$, then from Lemma 1, it can be known that $P^TR^{-1}P$ is invertible. The proof is complete.

Example 1 First consider the initial boundary value problem of the general training information equation.

Example 1: Generally, the initial boundary value problem of the training information equation is considered first.

$$\begin{cases} \dfrac{\partial u}{\partial t}+\dfrac{\partial u}{\partial x}-\dfrac{\partial^2 u}{\partial x^2}=\left[1-2e^{-1}-\left(1-e^{-1}\right)x+e^{-(1-x)}\right]e^{-t}, & x\in[0,1],t\geq 0 \\ u(x,0)=u_0(x), & x\in[0,1] \\ u(0,t)=u(1,t)=0 & t\geq 0 \end{cases}$$

Obviously, here $a(x,t)=b(x,t)=c(x,t)=1$ The exact solution to this problem is:

$$u(x,t)=\left[e^{-1}+\left(1-e^{-1}\right)x-e^{-(1-x)}\right]e^{-t}.$$

We solve it using the methods discussed in this section. Here, the radial basis function is taken as the Guass function: $R_j(x)=e^{-c_{jj}^2}$, and the polynomial basis is the linear basis $P^T(x)=[1,x]$.

In order to better judge the feasibility of the algorithm, the concept of error is introduced:

$$relative\ error=\frac{\sum|Exact\ solution\ \text{-}\ numerical\ solution\,|}{\sum|Exact\ solution\,|}.$$

In this paper, the solution interval is divided into ten equal parts (n=11, m=2), the time step $\Delta t=0.004$ is taken, and when iteratively reaches $T=0.2s$, the exact solution, numerical solution and error curve are shown in Figure 2.

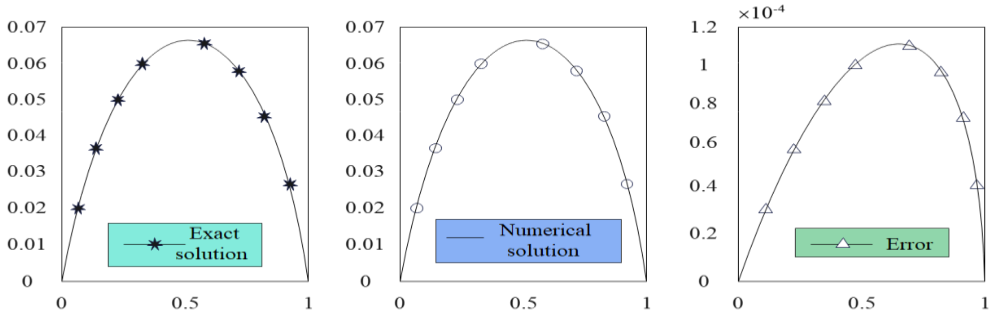


Figure 2 Exact solution, numerical solution and error curve at t=0.2

Example 2: The initial boundary value problem model of the human resource training dominant diffusion equation is considered.

$$\begin{cases}\dfrac{\partial u}{\partial t}+\dfrac{\partial u}{\partial x}-0.001\times\dfrac{\partial^2 u}{\partial x^2}=\left[x(1-x)+t-0.997tx-0.999tx^2\right]e^x, & x\in[0,1],\\ u(x,0)=u_0(x), & t\geq 0\\ u(0,t)=u(1,t)=0 & t\geq 0\end{cases}$$

The exact solution of this model is $u(x,t)=tx(1-x)e^x$.

We divide the solution interval into 20 equal parts (n=21, m=2), the time step is $\Delta t=0.005$, and when W=2 is calculated, the calculation results are as shown in Figure 3:

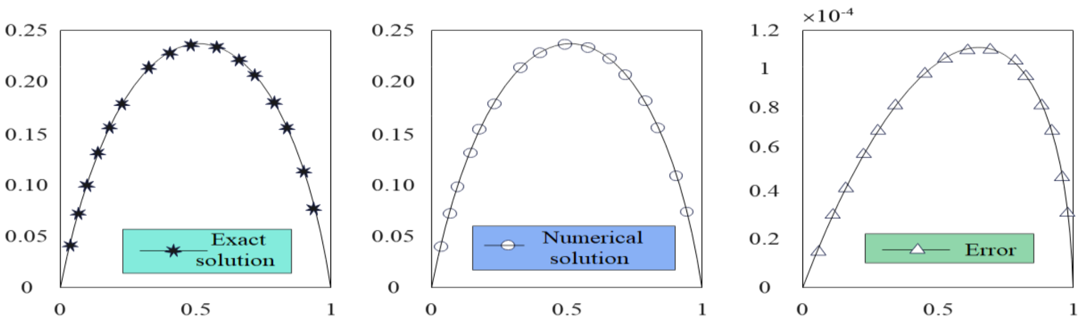


Figure 3 Exact solution, numerical solution and error curve at t=0.5

Example 3: The initial boundary value problem model of the dominant diffusion equation for human resource training is considered:

$$\begin{cases} \dfrac{\partial u}{\partial t}+\dfrac{\partial u}{\partial x}-\dfrac{1}{\pi^2}\times\dfrac{\partial^2 u}{\partial x^2}=\pi e^{-t}\cos\pi x, & x\in[0,1], \quad t\geq 0 \\ u(x,0)=u_0(x), & x\in[0,1] \\ u(0,t)=u(1,t)=0 & t\geq 0 \end{cases}$$

The exact solution of this model is $u(x,t)=e^{-t}\sin\pi x$.

We divide the solution interval into 20 equal parts (n=21, m=2), the time step is $\Delta t=0.0025$, and when $T=0.6$ is calculated, the calculation result is as shown in Figure 4:

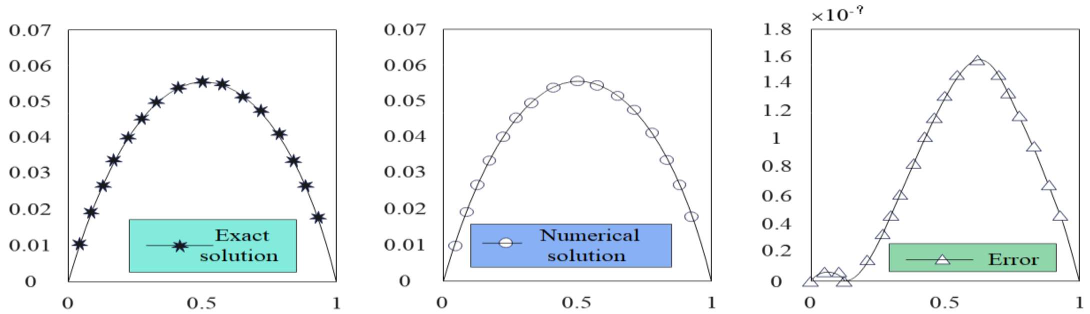


Figure 4 Exact solution, numerical solution and error curve at t=0.6

It can be seen from the above examples that the numerical solution obtained by the method in this paper is in good agreement with the exact solution. Comparing it with the mature finite element method, we know that it is also an effective numerical algorithm. Moreover, in the actual derivation algorithm process, the finite element method requires mesh division, and a large number of integral calculations are required on the formed mesh to obtain the final solution matrix. In this method, the final solution matrix can be obtained by directly substituting the constructed interpolation function into the equation. Therefore, its actual calculation amount is much smaller than that of the finite element method, and it is simpler than the finite element method. In summary, the point interpolation meshless method is another new, effective and simple numerical method for solving the training information equation.

2.2 Point interpolation algorithm for 2D training information equation

We solve the domain Ω with $N\times M$ nodes $(x_i,y_j)(i=1,2,\cdots,N, j=1,2,\cdots,M)$ discrete, the approximate function $u^h(x,y)$ of the function u(x, y) in the domain Ω can take the following mode:

$$u^h(x,y)=\sum_{n=1}^{N\times M}R_n(x,y)a_n+\sum_{m=1}^{Q}P_m(x,y)b_m=R^T(x,y)a+P^T(x,y)b \quad (20)$$

Among them, $R_n(x,y)$ is the radial basis function, a_n is the coefficient of $R_n(x,y)$, $P_m(x,y)$ is the monomial basis function defined on the plane rectangular coordinate system, b_m is the coefficient of $P_m(x,y)$, $N\times M$ is the number of nodes in the shadow field of node x, Q is the number of functions of the monomial basis, usually $Q<<N\times M$.

$$R^T(x,y)=\left[R_1(x,y),R_2(x,y),\ldots,R_{N\times M}(x,y)\right], \quad (21)$$

$$a=\left[a_1,a_2,\ldots,a_{N\times M}\right], \quad (22)$$

$$P^T(x,y)=\left[P_1(x,y),P_2(x,y),\ldots,P_Q(x,y)\right], \quad (23)$$

$$b=\left[b_1,b_2,\ldots,b_Q\right], \quad (24)$$

Substituting the node information into formula (20), we get:

$$u_{i,j}=u\left(x_i,y_j\right)=\sum_{n=1}^{N\times M}R_n\left(x_i,y_j\right)a_n+\sum_{m=1}^{Q}P_m\left(x_i,y_j\right)b_m i=1,2,\ldots N;\ j=1,2,\ldots,M \quad (25)$$

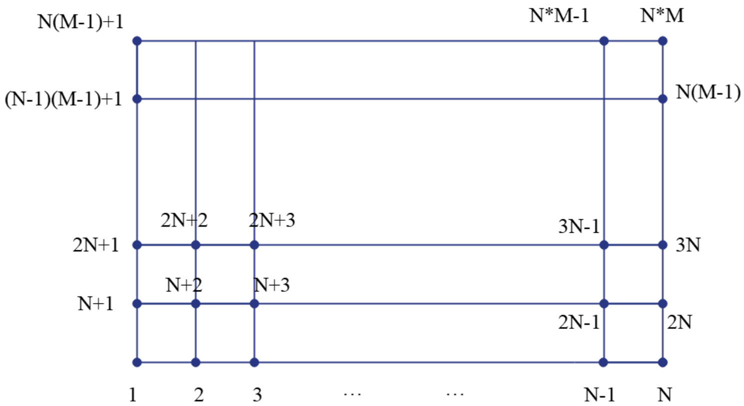


Figure 5 Node division diagram

As shown in Figure 5, we sort the points on the plane area by the method of first and then column, indicating that $u_{i,j}$ is represented by u_k, and their subscripts satisfy the relation:

$$i+(j-1)\times N=k \quad (26)$$

Now formula (25) can be written in matrix form as:

$$u^e=R_0a+Pb \quad (27)$$

Among them, $u^e=\left[u_1,u_2,\ldots,u_{N\times M}\right]^T$.

$$R_0=\begin{bmatrix} R_1\left(x_1,y_1\right) & R_2\left(x_1,y_1\right) & \ldots & R_{N\times M}\left(x_1,y_1\right) \\ R_1\left(x_2,y_1\right) & R_2\left(x_2,y_1\right) & \ldots & R_{N\times M}\left(x_2,y_1\right) \\ \vdots & \vdots & & \vdots \\ R_1\left(x_N,y_M\right) & R_2\left(x_N,y_M\right) & \ldots & R_{N\times M}\left(x_N,y_M\right) \end{bmatrix} \quad (28)$$

Obviously, the distance has no direction, and the inherent $R_i\left(x_i,y_j\right)=R_j\left(x_i\right)$, so R_0 is a symmetric matrix.

$$P=\begin{bmatrix} P_1\left(x_1,y_1\right) & P_2\left(x_1,y_1\right) & \ldots & P_Q\left(x_1,y_1\right) \\ P_1\left(x_2,y_1\right) & P_2\left(x_2,y_1\right) & \ldots & P_Q\left(x_2,y_1\right) \\ \vdots & \vdots & & \vdots \\ P_1\left(x_N,y_M\right) & P_2\left(x_N,y_M\right) & \ldots & P_Q\left(x_N,y_M\right) \end{bmatrix} \quad (29)$$

To ensure the uniqueness of the approximate function, the following conditions are added to the coefficients:

$$\sum_{n=1}^{N\times M} P_m\left(x_i, y_j\right) a_n = 0, m = 1,2,\ldots,Q \quad and \quad i + (j-1)\times N = n, i = 1,2,\ldots N, j = 1,2,\ldots,M. \quad (30)$$

It is written in matrix form:

$$P^T a = 0. \quad (31)$$

From formula (27), we get:

$$a = R_\theta^{-1} u^e - R_\theta\Big)^{-1} Pb \quad (32)$$

Substituting it into formula (31), we get:

$$b = S_b u^e \quad (33)$$

Among them, there are:

$$S_b = \left[P^T R_0^{-1} P\right]^{-1} P^T R_\theta^{-1} \quad (34)$$

Substituting formula (33) into formula (32), we get:

$$a = S_a u^e \quad (35)$$

Among them, there are:

$$S_a = R_\theta^{-1} - R_0^{-1} P S_b \quad (36)$$

Substituting formula (33) (36) into formula (20), we get:

$$u^h(x,y) = \left[R^T(x,y) S_a + P^T(x,y) S_b\right] u^e = \varphi(x,y) u^e \quad (37)$$

Among them, $\varphi(x,y)$ is a shape function matrix:

$$\varphi(x,y) = R^T(x,y) S_a + P^T(x,y) S_b = \left[\phi_1(x,y), \phi_2(x,y), ..\phi_n(x,y)\right] \quad (38)$$

Here, there are:

$$\phi_k(x,y) = \sum_{n=1}^{N\times M} R_n(x,y) S_{nk}^a + \sum_{m=1}^{Q} P_m(x,y) S_{mk}^b. \quad (39)$$

Among them, S_{nk}^a is the (n, k)th element in the matrix S_a, and $S_{mk}{}^b$ is the (m, k)th element in the matrix S_b. The shape function of this fruit satisfies the condition $\varphi_i\left(x_j\right) = \delta_{ij}$. The shape function derivative is:

$$\frac{\partial \phi_k(x,y)}{\partial x} = \sum_{n=1}^{N\times M} \frac{\partial R_n(x,y)}{\partial x} S_{nk}^a + \sum_{m=1}^{Q} \frac{\partial P_m(x,y)}{\partial x} S_{mk}^b \quad (40)$$

$$\frac{\partial \phi_k(x,y)}{\partial y} = \sum_{n=1}^{N\times M} \frac{\partial R_n(x,y)}{\partial y} S_{nk}^a + \sum_{m=1}^{Q} \frac{\partial P_m(x,y)}{\partial y} S_{mk}^b \quad (41)$$

$$\frac{\partial^2 \phi_k(x,y)}{\partial x^2} = \sum_{n=1}^{N\times M} \frac{\partial^2 R_n(x,y)}{\partial x^2} S_{nk}^a + \sum_{m=1}^{Q} \frac{\partial^2 P_m(x,y)}{\partial x^2} S_{mk}^b \quad (42)$$

$$\frac{\partial^2 \phi_k(x,y)}{\partial y^2} = \sum_{n=1}^{N\times M} \frac{\partial^2 R_n(x,y)}{\partial y^2} S_{nk}^a + \sum_{m=1}^{Q} \frac{\partial^2 P_m(x,y)}{\partial y^2} S_{mk}^b \quad (43)$$

Since the training information equations derived from practical problems are often occupied by human resource training, the initial boundary value problem of the two-dimensional human resource training dominant diffusion equation is considered:

$$\begin{cases} c(x,y)\frac{\partial u}{\partial t} + b_1(x,y)\frac{\partial u}{\partial x} + b_2(x,y)\frac{\partial u}{\partial y} - \frac{\partial}{\partial x}\left(a(x,y)\frac{\partial u}{\partial x}\right) - \frac{\partial}{\partial y}\left(a(x,y)\frac{\partial u}{\partial y}\right) = f(x,y,t) \\ u(x,y,0) = d(x,y) \\ u(0,y,t) = g_1(y,t), u(L,y,t) = g_2(y,t) \\ u(x,0,t) = h_1(x,t), u(x,L,t) = h_2(x,t) \end{cases} \quad (44)$$

Among them, $(x,y,t) \in [0,L] \times [0,L] \times [0,T)$.

Next, we will derive its differential format.

In the first step, first we transform formula (44) into the corresponding characteristic-difference scheme.

We set $\psi(x,y) = \sqrt{c^2(x,y) + b_1^2(x,y) + b_2^2(x,y)}$, and set the operator associated with the feature direction $\tau = \left(\frac{c(x,y)}{\psi(x,y)}, \frac{b_1(x,y)}{\psi(x,y)}, \frac{b_2(x,y)}{\psi(x,y)}\right)$ to be $c(x,y)\frac{\partial}{\partial t} + b_1(x,y)\frac{\partial}{\partial x} + b_2(x,y)\frac{\partial}{\partial y}$. At this time, we have:

$$\frac{\partial}{\partial \tau} = \frac{c(x,y)}{\psi(x,y)}\frac{\partial}{\partial t} + \frac{b_1(x,y)}{\psi(x,y)}\frac{\partial}{\partial x} + \frac{b_1(x,y)}{\psi(x,y)}\frac{\partial}{\partial y} \quad (45)$$

Thus, equation (44) can be rewritten in the characteristic form:

$$\begin{cases} \psi(x,y)\frac{\partial u}{\partial \tau} - \frac{\partial}{\partial x}\left(a(x,y)\frac{\partial u}{\partial x}\right) - \frac{\partial}{\partial y}\left(a(x,y)\frac{\partial u}{\partial y}\right) = f(x,y,t) & (46) \\ u(x,y,0) = d(x,y) & (47) \\ u(0,y,t) = g_1(y,t), \quad u(L,y,t) = g_2(y,t) & (48) \\ u(x,0,t) = h_1(x,t), \quad u(x,L,t) = h_2(x,t) & (49) \end{cases}$$

We take the time step as $\Delta t > 0$, divide the time interval [0, T), and divide the point as $t_k = k\Delta t (k = 0,1,\ldots)$. The coordinates of the intersection point between the characteristic direction starting from $\left(x,y,t^k\right)$ and the surface $t = t^{k-1}$ are:

$$\bar{x} = x - \frac{b_1(x,y)}{c(x,y)}\Delta t, \bar{y} = y - \frac{b_2(x,y)}{c(x,y)}\Delta t \quad (50)$$

Obviously, the derivative of u with respect to time is differentially discretized along the characteristic line as:

$$\left(\psi\frac{\partial u}{\partial \tau}\right)^k \approx \psi(x)\frac{u\left(x,y,t^k\right) - u\left(\bar{x},\bar{y},t^{k-1}\right)}{\sqrt{(x-\bar{x})^2 + (y-\bar{y})^2 + (\Delta t)^2}} = c(x,y)\frac{u\left(x,y,t^k\right) - u\left(\bar{x},\bar{y},t^{k-1}\right)}{\Delta t}. \quad (51)$$

Substituting formula (50) into formula (46), when $t = t_k$, there are:

$$c(x,y)\frac{u\left(x,y,t^{k}\right)-u\left(\overline{x},\overline{y},t^{k-1}\right)}{\Delta t}-\frac{\partial}{\partial x}\left(a(x,y)\frac{\partial u\left(x,y,t^{k-1}\right)}{\partial x}\right)-\frac{\partial}{\partial y}\left(a(x,y)\frac{\partial u\left(x,y,t^{k-1}\right)}{\partial y}\right) \quad (52)$$
$$= f\left(x,y,t^{k-1}\right)+r^{k}(x,y)$$

Among them, $r^{k}(x,y)$ is the local truncation error caused by the differential discretization of the eigendirection derivative.

The corresponding characteristic difference format can be obtained by deforming, sorting out and discarding the local truncation error:

$$u^{k}=\overline{u}^{k-1}+\frac{\Delta t}{c}\left(\frac{\partial}{\partial x}\left(a\frac{\partial u^{k-1}}{\partial x}\right)+\frac{\partial}{\partial y}\left(a\frac{\partial u^{k-1}}{\partial y}\right)+f^{k-1}\right) \quad (53)$$

Among them, $u^{k}=u\left(x,y,t_{k}\right),\hat{u}^{k-1}=u\left(\overline{x},\overline{y},t_{k-1}\right),c=c(x,y),a=a(x,y),f^{k-1}=f\left(x,y,t_{k-1}\right)$.

The second step is to construct the approximate function by point interpolation meshless method.

The solution area $[0,L]\times[0,L]$ is discretized and marked with $N\times M$ nodes $\left(x_{i},y_{j}\right)(i=1,2,\mathrm{L}\ ,N,j=1,2,\mathrm{L}\ ,M)$, including boundary points, as shown in Figure 5. In this way, at the time layer $t=t^{k}$, the approximate function of the function u(x,t) in the solution domain can be constructed by the point interpolation method, forming the following function representation:

$$v(x,y)=\sum_{n=1}^{N\times M}R_{n}(x,y)\alpha_{n}^{k}+\sum_{m=1}^{Q}P_{m}(x,y)\beta_{m}^{k} \quad (54)$$

Among them, $\alpha_{1}^{k},\alpha_{2}^{k},\ldots,\alpha_{N\times M}^{k},\beta_{1}^{k},\beta_{2}^{k},\ldots,\beta_{Q}^{k}$ is the undetermined coefficient. We use v^{k} to represent the vector formed at the time layer $t=t_{k}$, as follows:

$$v^{k}=\left[v_{1}{}^{k},v_{2}{}^{k},\ldots,v^{k}{}_{N\times M}\right]^{T},$$
$$\beta^{k}=S_{b}v^{k},\alpha^{k}=S_{a}v^{k},k=0,1,2,\mathrm{L}$$

S_{a}、S_{b} are determined by equations (34) and (36) corresponding to the time layer, respectively.

The third step is to establish the feature difference-point interpolation calculation format.

Substituting formula (53) into formula (52), we get:

$$\begin{aligned}
v^{k}(x,y)&=\overline{v}^{k-1}(x,y)\\
&+\frac{\Delta t}{c}\left\{\sum_{n=1}^{N\times M}\alpha_{n}^{k-1}\left[\frac{\partial}{\partial x}\left(a(x,y)\frac{\partial R_{n}(x,y)}{\partial x}\right)+\frac{\partial}{\partial y}\left(a(x,y)\frac{\partial R_{n}(x,y)}{\partial y}\right)\right]\right.\\
&+\sum_{m=1}^{Q}\beta_{m}^{k-1}\left[\frac{\partial}{\partial x}\left(a(x,y)\frac{\partial P_{m}(x,y)}{\partial y}\right)+\frac{\partial}{\partial y}\left(a(x,y)\frac{\partial P_{m}(x,y)}{\partial y}\right)\right]\\
&\left.+f^{k-1}(x,y)\right\}
\end{aligned} \quad (55)$$

We substitute the node $\left(x_{i},y_{i}\right)(i=1,2,\mathrm{L}\ ,N,j=1,2,\mathrm{L}\ ,M)$ information into the four equations (54), (47), (48) and (49) in turn, we get:

$$\begin{cases} v_{i+(j-1)\times N}^{k} = \overline{v}_{i+(j-1)\times N}^{k-1} \\ + \dfrac{\Delta t}{c_{i+(j-1)\times N}} \begin{cases} \sum_{n=1}^{N\times M} \alpha_n^{k-1} \left[\dfrac{\partial}{\partial x}\left(a(x,y)\dfrac{\partial R_n(x,y)}{\partial x} \right) + \dfrac{\partial}{\partial y}\left(a(x,y)\dfrac{\partial R_n(x,y)}{\partial y} \right) \right]_{\substack{x=x_i \\ y=y_i}} \\ + \sum_{m=1}^{Q} \beta_m^{k-1} \left[\dfrac{\partial}{\partial x}\left(a(x,y)\dfrac{\partial P_m(x,y)}{\partial x} \right) + \dfrac{\partial}{\partial y}\left(a(x,y)\dfrac{\partial P_m(x,y)}{\partial y} \right) \right]_{\substack{x=x_i \\ y=y_i}} \\ + f_{i+(j-1)\times N}^{k-1} \Big\}, \quad 2 \le i \le N-1, 2 \le j \le M-1, k=1,2,\mathrm{L} \end{cases} & (56) \\ v_{i+(j-1)\times N}^{0} = d\left(x_i, y_j, 0\right), 1 \le i \le N, 1 \le j \le M & (57) \\ v_{1+(j-1)\times N}^{k} = g_1\left(y_j, t_k\right), v_{N+(j-1)\times N}^{k} = g_2\left(y_j, t_k\right), 1 \le i \le N, 1 \le j \le M, k=1,2,\mathrm{L} & (58) \\ v_i^k = h_1\left(x_i, t_k\right), v_{i+(M-1)\times N}^{k} = h_2\left(x_i, t_k\right), 1 \le i \le N, 1 \le j \le M, k=1,2,\mathrm{L} & (59) \end{cases}$$

Among them, $v_{i+(j-1)\times N}^{k}$ represents the value of u(x, y) at point $\left(x_i, y_j\right)$ at time t^k, and $\hat{v}_{i+(j-1)\times N}^{k-1} = v\left(\overline{x}_i, \overline{y}_j, t^{k-1}\right) = v\left(x_i - \dfrac{b\left(x_i, y_j\right)}{c\left(x_i, y_j\right)}\Delta t, y_j - \dfrac{b_2\left(x_i, y_j\right)}{c\left(x_i, y_j\right)}\Delta t, t^{k-1} \right)$, $f_{i+1\,j-1\times N}^{k}$ is the value of f(x, y, t) at point $\left(x_i, y_j\right)$ at time t^k. The formulas (56) and (59) are the required characteristic difference-point interpolation calculation format. From formula (57), we know the initial value vector v^0 when the time horizon t=0. Then we substitute them into $\alpha^0 = S_a v^0, \beta^0 = S_b v^0$ to get α^0, β^0, and calculate $\hat{v}_{i+(j-1)\times N}^{0} = v\left(\overline{x}_i, \overline{y}_j, 0\right)$ at the same time, and then substitute the above results into formula (56) to get the vector v^1. Repeat the above steps to obtain v^2,v^3L in turn, so that the approximate discrete value of the function u=u(x,t) at any time layer $t_k = k\Delta t(k > 0)$ can be obtained.

This paper considers the initial boundary value problem model of the human resource diffusion equation:

$$\begin{cases} \dfrac{\partial u}{\partial t} + \dfrac{\partial u}{\partial x} + \dfrac{\partial u}{\partial y} - \dfrac{1}{2\pi^2}\left(\dfrac{\partial^2 u}{\partial x^2} + \dfrac{\partial^2 u}{\partial y^2} \right) = \pi e^{-t} \sin((x+y)\pi), \\ u(x,y,0) = \sin(\pi x)\sin(\pi y), \qquad t \ge, y) \in [0,1] \times [0,1] \\ u(0,y,t) = 0, u(L,y,t) = 0, \\ u(x,0,t) = 0, u(x,L,t) = 0, \end{cases}$$

Here $a(x) = \dfrac{1}{2\pi^2}, b(x) = c(x) = 1, f(x,y,t) = \pi e^{-1} \sin((x+y)\pi)$, the exact solution of this problem is $u(x,y,t) = e^{-t} \sin(\pi x)\sin(\pi y)$.

We solve it using the method discussed in this paper.

The solution domain is $[0,1] \times [0,1]$, and 10×10 uniform nodes are used to discretize it, and the radial basis function is taken as the Guass function: $R_j(x,y)=e^{-cr_i^2}$, and the polynomial basis is linear $P^T(x)=[1,x,y]$. Moreover, we take the time step $\Delta t=0.004$, the time layer k is the exact solution at the fiftieth layer, the numerical solution of the method adopted in this paper and the numerical solution of the finite element method, and the relative error diagram of the numerical solution in this paper is shown in Figure 6:

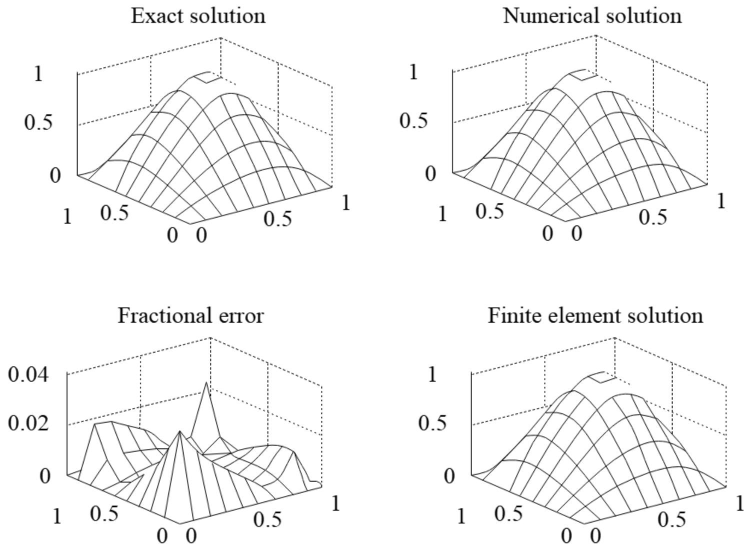


Figure 6 Exact solution, numerical solution, relative error and finite element solution at t=0.2

Then, its solution domain is [0,1]×[0,1] to discretize it with 20×20 uniform nodes, and take the same radial basis function and polynomial basis. At the same time, we take the time step Δt=0.002, the time layer k is the exact solution at the fiftieth layer, the numerical solution of the method adopted in this paper and the numerical solution of the finite element method, and the relative error diagram of the numerical solution in this paper is shown in Figure 7:

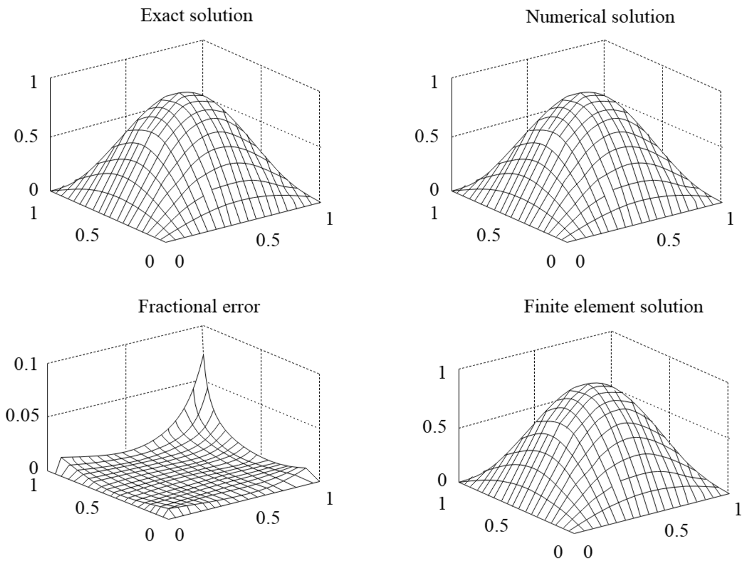


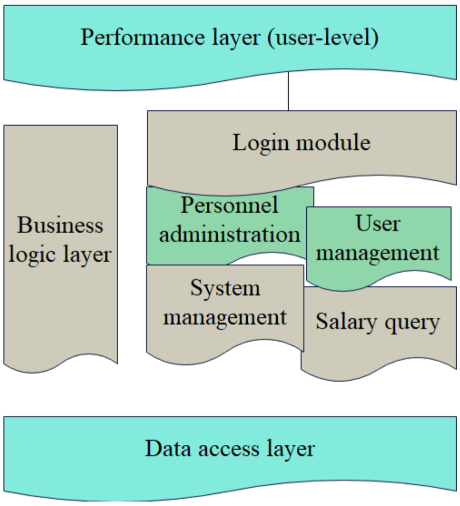
Figure 7 Exact solution, numerical solution, relative error and finite element solution at t=0.1

It can be seen from Figure6 and Figure7 that the numerical solution obtained by the method in this paper is in good agreement with the exact solution. In terms of the actual derivation algorithm process, or the calculation time, the calculation amount of the method in this paper is much smaller than that of the finite element method. To sum up, the point interpolation meshless method is a new, effective and simple numerical method for solving the linear pair training information equation, which is simpler than the finite element method.

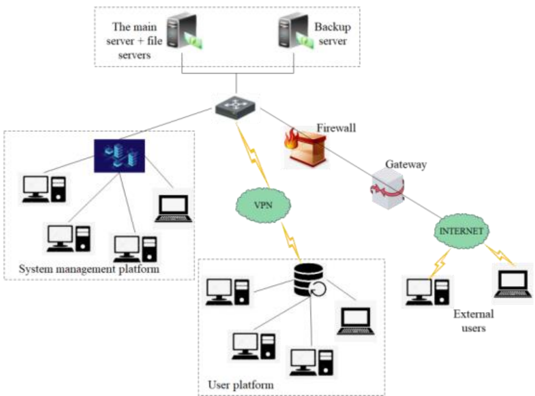
3 AN INNOVATIVE APPROACH TO ENTERPRISE HUMAN RESOURCES TRAINING BASED ON DEEP LEARNING

This paper constructs an enterprise human resources training system based on deep learning. The design of the system has three levels, namely the level where the database is located, the level where some functions of the system are located, and some levels where the users of the system are located. The user of the system directly contacts the interface layer of the system, and the layer where the system-related functions are located directly contacts the database of the system. The page level of the system directly contacts the level where some functions of the system are located. The above-mentioned structural relationship is shown in Figure 8(a).

The network architecture plays an important role in the overall design concept of the system. If the network architecture is good, the application capability of the system will be better, and not only that, the actual operation or operation of the system will be more stable. This article designs a related system for personnel management, when designing this system. The first step is to install the most core servers, which are generally installed in the most important computer rooms, and the most core servers are all 4U rack-mounted. This kind of server adopts the form of dual power supply hot backup, which can ensure that the system runs more safely and efficiently. The maintenance of this kind of system does not require much effort, and the administrator can complete it in the management platform. For users who are not within the relevant network range, they can still continue to access, as long as they use the technology of VPN. VPN technology is very good. Network users can use the system under any circumstances, and this technology improves the security and stability of the system, and can effectively prevent the entry of some illegal users on the network. The specific situation is shown in figure8(b).



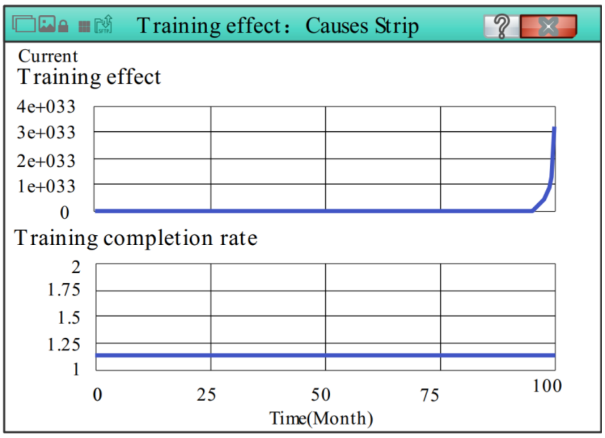
(a) Structure diagram of system logic



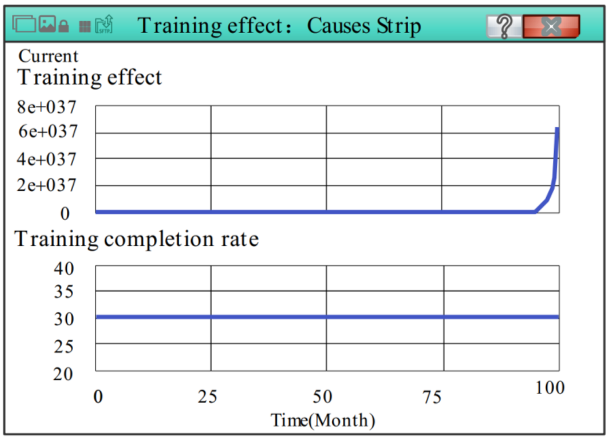
(b) Schematic diagram of system network deployment

Figure 8 Enterprise human resources training system based on deep learning

The basic assumptions are as follows. (1) We start by prescribing a number of people for training, and over time, some drop out and some join. (2) Our simulations can be simulated in the absence of data. The vensim software has this function, and the advantages of the software are reflected at this time. Therefore, we only study the change trend of the model, and study the trend through the change of the factor parameters, so as to demonstrate the hypothesis. The simulation results are shown in Figure 9(a). The training sensitivity is shown in Figure 9(b).



(a) Simulation diagram of the training effect



(b) Training sensitivity diagram

Figure 9 Simulation diagram of human resources training

The training completion rate directly affects the training effect, and they are positively correlated, that is, the greater the training completion rate, the better the training effect. Therefore, as long as the factors that can improve the training completion rate, we need to pay attention to it. Here, the adjustment of training policies and methods is regarded as the main factor for the training completion rate.

From the above analysis, it can be seen that the enterprise human resources training system based on deep learning proposed in this paper can effectively improve the effect of human resources training.

4 CONCLUSION

In the social and economic development and construction, the enterprise is the core force to promote economic growth. The management of human resources training in the development of the enterprise has become an important task of the human resources work of the enterprise. Strengthening the innovation of enterprise human resources and researching new development strategies will provide an important impetus for enterprises to face globalization in the future. If Chinese enterprises want to gain a firm foothold in the international economic market and expand their market share, they need to continuously reform the core of the enterprise. Therefore, this paper discusses the innovative path of enterprise human resources training mode in the new era. This paper combines deep learning technology to build an innovation system for enterprise human resources training. The simulation analysis results show that the enterprise human resources training system based on deep learning proposed in this paper can effectively improve the effect of human resources training.

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