Algorithm and Convergence Analysis of Absolute Value Equation Based on Hybrid Network

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Abstract. In view of the shortcomings of structured networks that it is difficult to manage complex shapes and unstructured networks cannot calculate the boundary layer viscous flow, an implicit algorithm based on mixed network points is proposed to solve the problem of successful calculation and high viscosity. Comparing absolute values is a difficult NP problem. It is caused by the interval problem and has a wide range of applications in many practical problems, such as: situation problems, semi-monitored and unprotected classification problems, and bag feasibility problems. When solving linear programming, double matrix strategy, quadratic programming and other problems, they must be converted into linear complementarity problems for processing, and linear complementarity problems can be summarized as absolute value equations. This article mainly introduces the smoothing Newton method of absolute value equation and the conjugate gradient algorithm of absolute value equation. This paper uses a hybrid network to analyze the algorithm and convergence of the absolute value equation, and establishes a potential mathematical model. The model is solved by the smoothing Newton method of the absolute value equation and the conjugate gradient algorithm of the absolute value equation, and the algorithm and convergence analysis results of the absolute value equation based on the hybrid network are evaluated, and the model is revised using historical data to improve The algorithm of the absolute value equation and the accuracy of the assessment of convergence analysis results. The experimental results in this paper show that the smoothing Newton method of the absolute value equation and the conjugate gradient algorithm of the absolute value equation increase the efficiency of the algorithm and convergence analysis of the absolute value equation by 23%, and reduce the false alarm rate and the false alarm rate. Finally, by comparing the experimental data analysis of the management strategy of sports services and the analysis of the reconstruction of sports services, the system illustrates the influence of artificial intelligence on the analysis of sports services' management strategies.

Keywords: hybrid network, absolute value equation algorithm, smoothing newton method, conjugate gradient algorithm
1. Introduction

1.1 Background and Significance
With the development of the mobile Internet, new technologies such as personalized advice have been discovered, media has become more intelligent, and the era of smart media is coming [1]. The research of absolute value equation comes from two aspects: linear complementarity problem and interval linear equation [2]. Interval linear equations means that the constant concepts and coefficients of the equation are unknown and have been established, but within a given interval, the number of equations is equal to the unknown number [3]. As far as optimization is concerned, the issue of complementarity is a very important research issue. Since this problem is another intersection of scientific research and computer research work, it is used in economics, engineering, transportation, mechanics and other application fields, there are sharp cost issues, unplanned procedures, motion theory, etc. [4-5]. Since the linear complementarity problem can be the problem of the absolute value equation, and because the problem of the absolute value equation has a unique and simple structure, the solution of the absolute value equation makes it a hot spot for optimization research [6-7].

1.2 Related Work
Xiaohui L provides a method that can evaluate participatory stakeholder innovation in a complex stakeholder environment to solve essential problems [8]. Based on the principle of common value creation, he proposed an analysis framework that illustrates the algorithm and convergence analysis process of the absolute value equation based on the hybrid network. In this process, the stakeholders integrate their resources and capabilities to develop innovations The smoothing Newton method of the absolute value equation and the conjugate gradient algorithm of the absolute value equation [9-10]. In order to evaluate this evaluation framework, a number of data were collected in the study. This case represents the significance of the analysis and system realization of the algorithm and convergence of the absolute value equation by the hybrid network [11-12]. Due to the error in the experimental process of this paper, the result is not very consistent with the actual prediction.

1.3 Main Content
The innovation of this paper is to propose the smoothing Newton method of absolute value equation and the conjugate gradient algorithm of absolute value equation. Based on the algorithm and convergence analysis of the absolute value equation under the background of the hybrid network, the algorithm and convergence of the absolute value equation are analyzed through the hybrid network. Establishing the smoothing Newton method of the second-order absolute value equation and the conjugate gradient algorithm of the absolute value equation combined with the calculation method of the hybrid network provide research guidance for the algorithm and convergence analysis of the absolute value equation under the background of the hybrid network.

2. Algorithm Based on the Absolute Value Equation of the Hybrid Network

2.1 Smoothing Newton's Method of Absolute Value Equation
In recent years, the in-depth study of inequalities can extract false other problems and atypical smoothing methods. These problems have gradually become more and more research in this field. To use a smooth sequence to solve the inhomogeneity problem, you need to find the function of the absolute value $|t|$. This document creates a smooth approximation function, uses the function here to convert a complete value equation problem into a smooth set, and then uses Newton’s smoothing algorithm to solve the equation. In order to approach $|t|$, This article establishes an approximation $|t|$, The smooth function of. For any $p \in [2, +\infty)$, define the function $\phi_p : R_+ \times R \rightarrow R$
The function $\varphi_p$ has the following properties: $\varphi_p$ defined by (1), it can be continuously differentiated on $\mathbb{R} \times \mathbb{R}$, $\|\varphi_p(\mu,t)\| < 4\mu$ For any $p \in [2,\infty)$, define the function $\phi_p : \mathbb{R}^2 \rightarrow \mathbb{R}$, $\phi_p(\mu,t) = \|\frac{\partial}{\partial \mu} \varphi_p(\mu,t)\| = \|t\|^p + |\mu|^p$. Then $\varphi_p(0,t) = |t|$, $\phi_p$ can be continuously differentiated on $\mathbb{R}^2 \backslash \{(0,0)\}$, and when $\frac{\partial \phi_p(\mu,t)}{\partial \mu} = \frac{\text{sng}(t)}{\phi_p(\mu,t)}|t|^{p-1}$ $(\mu,t) \neq (0,0)$, $\phi_p$ is strongly semi-smooth $\mathbb{R}^2$.

2.2 Conjugate Gradient Algorithm of Absolute Value Equation

The gradient method was first used in 1847 and was proposed by the mathematician Kao Qi. This method requires a small amount of calculation and does not need to choose a starting point, but because it only has a linear convergence rate when the iteration point is close to the minimum. The iterative zigzag phenomenon of the algorithm indicates the convergence speed of the algorithm. To solve this problem, the conjugate gradient method was created. This method improves the convergence speed by constructing the conjugate iteration direction and avoids the shortcomings of the gradient method.

The conjugate gradient method was first introduced in 1964 to solve the reduction problem. You can use the line search to reduce the algorithm. The conjugate gradient method has a unique initial function. This paper uses the conjugate gradient method to solve this problem. The advantages of the conjugate gradient method are small storage requirements and simple algorithm, which is very suitable for large-scale problems. This article solves the following problems through absolute value comparison: $Ax - |x| = b$ Remember $H(x) = Ax - |x| - b, Q = A - \text{diag} \left( \text{sgn}(x) \right)$, then find the absolute value of the equation, $Ax - |x| = b$ value of, Equivalent to the equation $H(x) = Qx - b$. On this basis, the value function is proposed:

$$h_\mu(x) = \frac{1}{2} \left( \|H(x)\|^2 + \mu \|x\|^2 \right).$$

Among them, $\mu \geq 0$ is the parameter. It can be obtained $h_\mu(x) = 0 \iff H(x) = 0, \mu = 0$. Therefore, the equation $Ax - |x| = b$ Equivalent to $\min_{x \in \mathbb{R}^n, \mu \in \mathbb{R}_+} h_\mu(x)$ Solution.

3. Algorithm and Convergence Analysis Experiment of the Absolute Value Equation Based on the Hybrid Network

3.1 Numerical Experiment Design

With the continuous penetration of the concept of hybrid networks, algorithm services have emerged. However, so far, there are almost no algorithms for absolute value equations and convergence analysis network algorithms. However, at this stage, the algorithm and convergence analysis of the absolute value equation are facing innovative requirements. In this case, applying the teaching concept of hybrid network theory to the algorithm and analyzing the convergence of the absolute equation will undoubtedly improve the research results. Therefore, this article provides numerical examples to test the feasibility and efficiency of the algorithm.
3.2 Numerical Experiment Collection

In the experiment, the parameters $\sigma=0.000$, $\delta=0.2$, $H_0=0.0001$, $\delta=1.0\times10^{-6}$ are used in the test. The termination criterion is $\|G(z^k)\| < \varepsilon$ or $\|G(z^k) - G(z^{k+1})\| < \varepsilon$. The initial points $x^0$ are respectively taken as: i) $x^0 = 2\times \text{randn}(200,1)-1$; (ii) $x^9 = (1,1,\ldots,1)$; (ii) $x^0 = (0,0,\ldots,0)$. In the experiment, choose $p = 2$, run each example 10 times, $\phi_p$ and $\phi_p$ take the average. Table 1 is the experimental data table of the function sum. Among them, Max, Min, It and T represent the maximum number of iterations, the minimum number of iterations, the average number of iterations, the average running CPU time, and after the algorithm ends, $\|G(z^k)\|$ The average and number of failures of the algorithm. When $p=2$, the calculation result of the function is relatively good. The data results are shown in Table 1:

| Function $\phi_p$ experimental result 1 | Max | Min | It | T  |
|----------------------------------------|-----|-----|----|----|
| Function $\phi_p$ experimental result 2 |     |     |    |    |

| Function $\phi_p$ experimental result 1 | 4   | 3   | 3.1| 0.134 |
| Function $\phi_p$ experimental result 2 | 11  | 6   | 9.7| 0.375 |

It can be seen from Table 1 that when $p=2$, the numerical result of the function $\phi_p$ is at a lower level than the numerical result of the function $\phi_p$. The numerical result of the function $\phi_p$ is the maximum number of iterations, the minimum number of iterations, the average number of iterations and running The average CPU time is less than the numerical result of the function $\phi_p$. In order to better see the relationship between the two, the data is analyzed, and the analysis results are shown in Figure 1:

![Figure 1](image-url)

**Figure 1.** Function $\phi_p$ and $\phi_p$ experimental results analysis diagram

It can be seen from Figure 1 that in solving this test problem, the maximum number of iterations, the minimum number of iterations, the average number of iterations, and the average CPU time of the function $\phi_p$ present a relatively gentle trend, with little fluctuations $\phi_p$, and the function $\phi_p$'s broken line Big ups and downs. Therefore, it is effective to solve the absolute value function of function $\phi_p$ smoothing after using the hybrid network with function.
4. Algorithm and Convergence Analysis of Absolute Value Equation Based on Hybrid Network

4.1 Convergence Analysis of Hybrid Algorithm

"Solis and Wets" provides a melee for general search algorithms and related theories. You can use the following form \(<\mathcal{A}, f>\) to write a question with general improvements. For a random search \(D\), the result \(k\)th is \(X\), and the following confirmation will be verified: the result is \(X\), \(x = D(X, 52)\). Where \(\mathcal{A}\) is the \(\sigma\) field of a specific subset of \(\mathbb{R}\). \(F\) is the fitness function, and \(\zeta\) is the solution found in the process of improving the \(D\) algorithm.

Instruction 1: If \(\zeta \in \mathcal{A}\), then algorithm \(D\) satisfies \(f(D(x, \zeta)) \leq f(x)\), then \(f(D(x, \zeta)) \leq f(\zeta)\). The first standard requires the random search algorithm \(d\) to be uniform without increment to ensure that the value of the condition \(f(x)\) does not increase. Criterion 2 For any \(P\), if \(\mathbb{V}(P) > 0:\)

\[
\prod_{k=0}^{m}(t, \mu_k(P)) = 0, \text{among them } \mu_k(P)\text{. In the } k\text{th iteration of } P, \text{ algorithm } D \text{ detects the probability measure of the solution. Criterion 2 states that as long as the probability of subset } P \text{ in space } \mathcal{A} \text{ is greater than zero, the algorithm will not be able to find a solution with infinite quality } P. \text{ If the } F \text{ function is measurable, then the measurable space is a measurable subset of } \mathcal{A}, \text{ and the algorithm satisfies the conditions } D1 \text{ and } D2, \text{ the Penalty is the solution range created by the } D \text{ algorithm, and then:}

\[
\lim_{k \to \infty} p(x_k \in R_{x,m}) = 1 \text{ among them, } p(x_k \in R_{x,m}) \text{ is the solution searched in step } k \text{ of algorithm } D.
\]

In order to measure the probability of the best region \(R\), the hybrid algorithm cannot be combined with the global solution and the best probability 1. The fitness calculation process using the principle of the K-means algorithm will not affect the convergence of the hybrid algorithm. This proves that the whole beginning will not directly affect the convergence of the algorithm. Therefore, in order to prove the global convergence of the hybrid algorithm, only the algorithm of the absolute value equation needs to be proved. For the absolute value equation, it is sufficient to use a hybrid algorithm for the global concentration of the collaborative process.

4.2 Convergence Analysis Of Conjugate Gradient Algorithm

This paper studies the algorithm to solve the problem by calculating the full value. In order to simplify the solution of calculating integer values, this paper constructs a new smooth approximation function for the entire value of the function, and uses this function to convert the entire value into a static value problem decomposed into smooth values. Then, solve it with the aid of a simplified algorithm. Under proper conditions, the alignment of the algorithm can be guaranteed, and the quantitative results show the influence of the algorithm.

In addition, in order to solve the absolute value equation, a new value function is constructed for the absolute value equation, which explains the continuity of the function gradient and the horizontal setting boundary, and then uses the conjugate gradient algorithm. The equation of the calculation equation proves the global convergence of the algorithm, and the numerical results prove the effectiveness of the algorithm.

Table 2. Experimental data table of conjugate gradient algorithm

| Example  | Optimal solution | Operation hours | Number of iterations | Function value       |
|----------|------------------|-----------------|----------------------|----------------------|
| Example 1| \((1,1,1,1)^T\)  | 0.0044          | 7                    | 1.6766e-16           |
| Example 2| \((1,1)^T\)      | 0.0019          | 4                    | 1.8519e-12           |
| Example 3| \((1,1,1,1)^T\)  | 0.0023          | 8                    | 8.1311e-17           |

In this paper, combined with the hybrid network, the feasibility and effectiveness of the algorithm
are verified through numerical examples. In the experiment, take the parameter $p=0.5, \delta_1=0.2, \mu_0 =0.0001, \epsilon =1.0\times10^{-6}$. The termination criterion is $\| \nabla h_{\text{ad}}(x^*) \| \leq \epsilon$. Set the maximum number of iterations to 200. The data results are shown in Table 2:

It can be seen from the experimental results in Table 2 that the algorithm in this paper can solve absolute equations. Table 2 lists the operation time, number of iterations, and function values of the absolute value equations of different sizes in Example 1, Example 2, and Example 3. In the experiment, each case was run 10 times and the average value was taken. In order to be able to clearly see the relationship between the data in the table, the execution time and the number of iterations in Table 2 are analyzed using statistical graphs. The analysis results are shown in Figure 2:

![Figure 2. Experimental data analysis diagram of conjugate gradient algorithm](image)

Figure 2 shows that when $n$ takes different values, with the help of the algorithm in this article, Example 1, Example 2 and Example 3 can obtain the solution of the absolute value equation in a finite iteration step. It can be seen that the algorithm in this paper has a good effect on solving the absolute value equation, so the algorithm in this paper is feasible and effective.

Acknowledgment

Although this paper has made some research results on the smoothing Newton method of the absolute value equation and the conjugate gradient algorithm of the absolute value equation, there are still many shortcomings. The algorithm and convergence analysis method of the absolute value equation of the hybrid network still has a lot of in-depth content worthy of study. There are many steps in the analysis process that cannot be covered because of space and personal ability. In addition, the actual application effect of the improved algorithm can only be compared with the traditional model from the level of theory and simulation.

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