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COMPUTER SOFTWARE MAINTENANCE AND OPTIMIZATION BASED ON IMPROVED GENETIC ALGORITHM

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Abstract. Optimizing computer software maintenance is the key goal, which also ensures dependable and consistent network performance. In order to increase genetic operations and evaluate the satisfaction and fitness index functions, this article employs an improved genetic algorithm. Utilizing the network's performance and controlling restrictions through controlled data iterations, the architecture is refined. The study also finds a link between the number of iterations and the rate of network optimization, supporting the results of the genetic algorithm. The results show that the reliability of the network system decreases as the number of genetic operation repeats increases. If a critical point is reached, the enhancement in network reliability tends to level off due to hardware constraints or other relevant factors. Notably, the study identifies the maximum attainable value of network reliability at 0.894, precisely at 100 iterations. These conclusions offer an essential framework for optimizing the design of computer network reliability, emphasizing the necessity of a well-balanced approach to genetic algorithm-based optimization.

Key words: Computer Networks; Genetic Algorithm; Network Optimization; Network Reliability; Iterative Analysis

1. Introduction.

The robustness of computer networks, fundamental to their operation, stems from their innate capacity to endure and withstand potential damage and disruptions. This flexibility empowers networks to sustain a strong and smooth operational cycle, enabling the efficient and timely implementation of updates and ensuring a consistent, stable performance during real-time operations. The ability to withstand various threats and disturbances is crucial for upholding the network's integrity and dependability, guaranteeing uninterrupted functionality even in the face of challenging circumstances. By nurturing this flexibility, computer networks can proficiently meet the demands of contemporary digital settings, maintaining an uninterrupted flow of data and information without compromising performance or stability [1]. Mismanagement of network stability can result in equipment malfunctions, severely threatening data preservation and potentially leading to data loss and system immobilization. Establishing reliable and secure computer networks necessitates integrating hardware and software functionalities. Particularly, network hubs serve as the primary stronghold of security, playing an irreplaceable role in the network infrastructure. Any failure within network hubs can directly impact user accessibility and significantly disrupt the overall user experience. Consequently, there is a pressing need for in-depth research and empirical analysis focused on optimizing computer technology, enhancing technical capabilities, and implementing refined solutions within the fundamental optimization framework [2].

Ensuring the resilience of computer networks demands a comprehensive approach that involves fortifying the system's defence mechanisms against potential threats, both internal and external. Strengthening the network's ability to withstand cyber-attacks, system failures, and data breaches is crucial to maintaining the integrity and functionality of the network infrastructure. Furthermore, prioritizing the operational cycle and optimizing the efficiency of network updates is imperative for ensuring whole and uninterrupted digital operations, allowing for quick adaptation to evolving technological demands [3].

The continuous integration of hardware and software components lays the foundation for a sturdy and dependable computer network. Harnessing the complementary features of these components in tandem is pivotal for unleashing the network infrastructure's complete capabilities. A cohesive and well-aligned hardware and software system not only boosts the network's efficiency but also reinforces its overall dependability and security, nurturing a unified environment capable of adapting to the dynamic requirements of the digital environment [4].

The foundation of evaluating the effectiveness of optimization strategies in enhancing computer network

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reliability lies in empirical analysis. Through comprehensive empirical studies, potential areas for enhancement can be identified, leading to targeted solutions that further strengthen the network infrastructure. Continuous monitoring and evaluation facilitate the identification of potential vulnerabilities, providing invaluable insights for refining existing network optimization strategies and ensuring consistent and robust network performance over time [5].

Establishing a strong and reliable computer network demands a comprehensive approach that addresses the diverse facets of network reliability. By emphasizing the integration of hardware and software, reinforcing defence mechanisms, and conducting empirical analyses, it becomes feasible to construct a robust and secure network architecture capable of withstanding the challenges posed by the contemporary digital landscape. Through a proactive and strategic approach, it is possible to enhance the reliability and security of computer networks, fostering a seamless and efficient digital environment for diverse user needs and demands [6].

The Committee, in its recent evaluation, expresses its sincere appreciation for the State party's continued dedication to reinforcing measures that ensure the unwavering commitment of States parties to the effective implementation of the Convention on the Privileges and Immunities for the Electronic Sphere (CPIES). This acknowledgement encompasses the concerted efforts made by the State party in bolstering the reliability of computer systems, which includes. Still, it is not limited to enhancing the flexibility of the external environment, stimulating the dependability of software and hardware components, and fostering the reliability of the personnel involved [7]. It is imperative to emphasize the need for continual advancements in software algorithms, fortifying the network's dependability, and refining the overall design while considering the optimal state of the hardware system. This concerted approach is a pivotal avenue for future development [8].

The ongoing research endeavours in China concerning the stability of computer networks primarily revolve around the intricate dynamics of telecommunications signal networks. By analyzing network signal failures, the transmission of telecommunications signals is strategically harnessed to facilitate dynamic capacity changes, enabling seamless transmission through the exchange of signals. A key role of this research involves the establishment of comprehensive parameters for network security authentication, laying the groundwork for formulating a robust evaluation system. This systematic approach is instrumental in facilitating the optimization design of the network, ensuring its performance and resilience under varying conditions [9,10].

2. Literature review. Employing a strategic approach rooted in topology planning has emerged as a pivotal strategy for circumventing network impediments. By carefully delineating network topologies, researchers aim to identify and overcome potential obstacles, thus fostering a more streamlined and efficient network infrastructure. As the landscape of intelligent optimization solutions continues to expand, the quest for viable and dependable network technology solutions remains an ongoing pursuit. Notably, optimization methods have played a pivotal role in advancing this endeavour. One notable technique involves the strategic deployment of genetic algorithms, which have been effectively tailored to achieve comprehensive network optimization, particularly regarding granularity considerations. Consequently, this concerted multidimensional approach, integrating multi-objective methodologies, has continuously refined network optimization strategies, thereby establishing a robust foundation for continual evolution and enhancement of network stability [11].

The significance of reliable computer networks in modern society forms a central theme, encompassing the multifaceted implications of network failures across diverse sectors. It emphasizes the fundamental role of robust network infrastructures in supporting the smooth functioning of contemporary industries and societal operations. Examining the historical development of network reliability underscores the evolution of key concepts and breakthroughs, charting the progression of strategies to enhance network stability. This historical perspective sheds light on the trajectory of advancements in hardware, software, communication protocols, and network architectures, all of which have shaped the current landscape of network reliability [12].

The authors examine several solutions, such as fault-tolerant architectures, neural networks, genetic algorithms, and redundancy protocols, to optimize network reliability. This research provides insights into the applicability and success of each strategy in real-world circumstances by critically evaluating its strengths and limits without case studies and empirical research, which offer real-world examples of how to apply particular techniques to increase network reliability. An essential tool for understanding the state of computer network reliability research from a broad perspective is explained. Its thorough analysis identifies any shortcomings or gaps in the current research, identifying particular areas that require more study and inquiry [13].

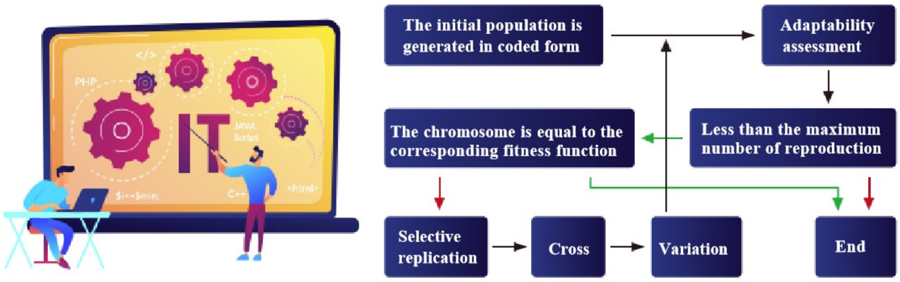

Fig. 3.1: The Proposed Genetic Algorithm Process

Providing insight into future possibilities for computer network dependability research and development, the assessment offers significant insights into the prospective trajectory of developments and the changing obstacles within the area by clarifying emerging trends, technological advancements, and creative techniques. The authors adopt interdisciplinary collaboration and exchanging ideas among researchers, practitioners, and stakeholders as a fundamental platform for ongoing exploration. Through fostering a thorough comprehension of the complex interactions among different factors that impact network reliability, the review hopes to encourage the creation of novel frameworks, approaches, and solutions that can further the development of resilient and strong computer networks [14].

3. Analysis of Computer Network Reliability Principles. The reliability of computer networks depends on the independence of individual systems. Seamless interaction among various network protocols is vital for tailored network operations. Ensuring the autonomy of each computer is fundamental, enabling the utilization of information resources across diverse network environments. This framework facilitates smooth information exchange across network terminals. Facilitating resource sharing among subnets and resource networks is critical for efficient asset utilization under varying network conditions. Data processing within computer networks is meticulously managed by implementing subnets, ensuring stable data utilization across the network infrastructure [15].

Given the expansive reach of computer networks, establishing stable communication channels while preserving network integrity is paramount. Algorithms strategically prioritize resource allocation between users and servers, enhancing the network's ability to manage and distribute resources effectively. This approach guarantees seamless data transmission, fostering a reliable and robust computer network infrastructure [16].

The innovative technique of adaptive stabilization, twisting biological mutation with computer science, has led to the conception of the genetic algorithm, represented in Figure 3.1. This algorithm serves as a pioneering solution at the intersection of these disciplines. Drawing inspiration from the cognitive processes observed in the biological realm, computer-based individuals operate autonomously, ensuring the continuous detection of algorithms across the entire system. Initially depicted as individual entities, these computer individuals combine into groups, forming an interconnected data matrix that is spatially organized. Leveraging diverse evaluation methodologies, genetic operators are crafted under specific crossing and mutation conditions, adhering to the principles of genetic computation.

Matrix computation systematically optimizes the genetic equation, enabling the seamless execution of coding and genetic operations. Within the intersection realm, the entire system's computational potency reinforces local search capabilities, supplementing the overarching search process. In optimizing genetic algorithms, the object encoded by parameters can be dynamically restructured, evading the constraints associated with data limitations. This adaptive approach significantly amplifies the breadth and depth of the search, leading to an enriched exploration of potential solutions [17,18].

3.1. Content of Computer Network Reliability Optimization. The optimization of computer network reliability involves a thorough analysis and calculation of diverse objectives. Emphasizing the performance characteristics within specific geographic regions, the focus remains on bolstering network stability and main-

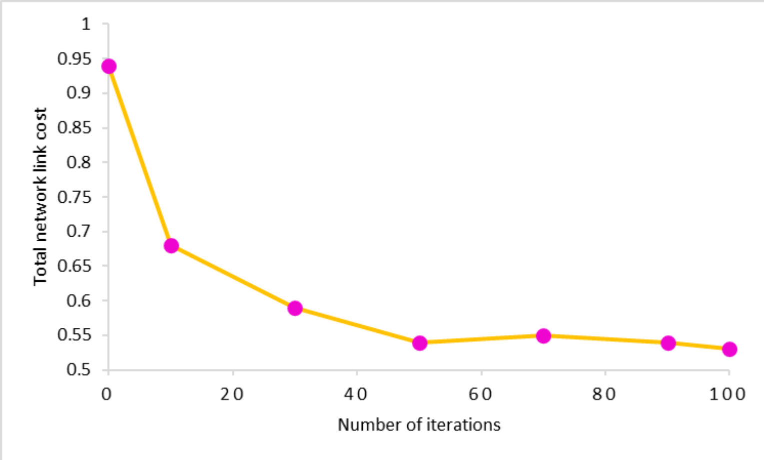

Fig. 3.2: Network Stability Data Iteration Curve

tainability. This holistic approach addresses the intricate challenges of optimizing multiple objectives, fostering a resilient and robust network structure.

The formulation of coding data schemes assumes a crucial role in enhancing computer network reliability. This process involves arranging genes into sequential chromosome patterns, generating initial entities that are subsequently grouped for streamlined operations. Computation of the fitness analysis for individual chromosomes facilitates the determination of inheritance probabilities for specific traits during subsequent stages. During the cross-operation phase, meticulous records of chromosome pairings guide the identification of an optimal pairing method. This intricate process ensures the seamless integration of diverse genetic elements, promoting the development of a sturdy and high-performing network infrastructure.

Throughout the optimization process, the satisfaction function serves as a critical metric, offering a comprehensive evaluation framework to assess the efficacy of the employed optimization strategies. This meticulous evaluation guarantees the alignment of the optimization process with predefined performance standards, thereby ensuring the stability and reliability of the computer network infrastructure is expressed as

$$sat\_cost(x) = \begin{cases} 1 \\ \frac{(1-b)(cost_{min}-x)}{cost_{opt}} + 1 \\ 0 \end{cases} \tag{3.1}$$

Among the critical factors, cost-min signifies the minimal expense linked to network optimization, while cos topt represents a slightly higher minimum value. Initial computations form the foundation for determining optimal weight values, adhering to reliability constraints, and ensuring a reliable network operation. Data failing to meet stringent constraints undergoes meticulous processing to guarantee the satisfaction of reliability benchmarks.

Utilizing the robust capabilities of the genetic algorithm, the iterative process steers the continuous evolution of the parent data through intricate algorithmic computations. This iterative process facilitates a comprehensive simulation, culminating in a stable data stability curve. This curve represents the culmination of multiple generational iterations, as evidence of the robustness and reliability of the applied optimization strategy, as depicted in Figure 3.2.

The methodology for optimizing the network aims to balance minimizing costs and maximizing reliability through this intricate process. The strategic alignment of these elements plays a crucial role in fostering an optimized network framework that is both cost-effective and resilient, meeting the demanding standards of contemporary network infrastructure.

The optimization direction is precisely determined in the initial calculation phase, ensuring the exclusion of unconstrained solutions during the genetic iteration process. With a focus on stability, various factors, including network information costs, are carefully considered, leading to iterative adjustments at different network nodes. These adjustments are guided by established satisfaction measurement standards, refining the weight calculation through systematic testing of diverse parameter values. This meticulous iterative approach guarantees the creation of a novel structural diagram that adheres to the network's topological constraints.

Significant variations in the optimized structure arise from changes in the parameter W. At the central point, each numerical variable bifurcates into three distinct trajectories, contributing to the formation of diverse structural trees. Leveraging these structural adaptations, the data iteration process is enhanced, resulting in the development of highly satisfactory genetic data following comprehensive reliability analyses. Consequently, addressing the practical challenge of increasing optimization costs, the optimization of computer network communication is successfully achieved within the parameters of the topology structure, thereby establishing a more robust and efficient network architecture [19].

4. 4.Optimization process for computer network reliability.

4.1. Optimization Criteria and Models for Computer Network Reliability. When designing the reliability of a computer, full consideration should be given to establishing a robust and efficient network infrastructure that relies heavily on carefully selecting appropriate and objective network topology models. This selection process, guided by thorough analysis and consideration, holds significant sway over the overall adaptability and performance of the network. By thoroughly assessing the specific requirements and objectives of the network environment, the chosen topology model ensures smooth data transmission, optimal resource allocation, and improved network management capabilities. Furthermore, this model forms the fundamental framework dictating the configuration and interconnection of network components, playing a crucial role in determining the network's fault tolerance, scalability, and overall operational efficiency.

Simultaneously, integrating fault tolerance and redundancy mechanisms into the network architecture is crucial to enhance its resilience and reliability. Incorporating robust redundancy protocols and fault-tolerant design elements allows the network to mitigate the impact of potential disruptions and failures effectively. This proactive design strategy minimizes downtime, data loss, and service interruptions, guaranteeing uninterrupted accessibility and consistent performance. Furthermore, integrating fault tolerance and redundancy measures fosters the development of a robust network infrastructure capable of swiftly adapting to unforeseen challenges, ensuring uninterrupted operations even during adverse events or system failures.

4.2. Network Optimization Design Based on Improved Genetic Algorithm. The optimization of genetic algorithm networks primarily depends on the effective utilization of the genetic algorithm and the critical coding scheme applied within the algorithm. The optimization process of genetic algorithm networks relies heavily on the strategic deployment of genetic algorithms, which excel in navigating complex problem spaces and deriving optimal solutions by emulating the fundamental principles of natural selection and evolution. These algorithms continuously generate increasingly refined solutions over iterative cycles by simulating natural genetic variations, selections, and reproductions. Notably emphasizing adaptability and robustness, genetic algorithms are powerful tools for addressing intricate optimization challenges, especially within computer networks.

Additionally, the efficacy of genetic algorithm network design is intricately linked to the specific coding scheme integrated into the algorithm. This coding scheme dictates how solutions are represented within the algorithm, significantly influencing the efficiency and precision of the optimization process. A delicate balance between solution intricacy and computational efficiency is achieved by meticulously defining the encoding strategy for various components and parameters within the genetic algorithm. The meticulous optimization of the coding scheme ensures that the genetic algorithm effectively explores the solution space and converges toward the most optimal network design configurations. Through meticulous optimization of the coding scheme, genetic algorithm networks can adeptly address complex network optimization challenges, thereby fostering the development of robust and efficient network architectures.

5. Simulation Results. To elaborate on the verification process and the comparison of the algorithm's effectiveness in optimizing computer network reliability design, it is crucial to emphasize the comprehensive

Table 5.1: Node Representation in Binary Gene Format

Node	Binary gene representation
N_1	$g_{11}, g_{12}, ..., g_{1n}$
N_2	$g_{21}, g_{22}, ..., g_{2n}$
...	...
N_m	$g_{m1}, g_{m2}, ..., g_{mn}$

Table 5.2: Total Cost of Network Media Comparison Across Different Algorithms

Techniques	Total cost of network media										
Neural network algorithm [20]	69.1	69.3	70.0	69.7	69.2	69.4	69.9	69.7	69.2	69.2	69.3
Inclusion and Exclusion principle algorithm [21]	68.6	68.9	68.3	68.6	68.4	68.5	68.4	68.3	68.3	68.4	68.0
Fuzzy Neural network algorithm [22]	67.7	67.9	68.2	68.1	68.6	68.6	68.6	68.7	68.6	68.6	69.4
Algorithm of this paper	67.2	67.4	67.4	67.1	67.2	67.3	67.4	67.6	67.3	67.1	67.0

approach adopted in the study. The evaluation is conducted within a standardized computer network reliability model alongside a detailed network link cost model. This standardized approach facilitates a systematic comparison between the improved genetic algorithm and other established algorithms, including the inclusion-exclusion principle algorithm, the fuzzy neural network algorithm, and the neural network algorithm. The study assesses the algorithm's effectiveness through a rigorous comparative analysis and delves into its progressive and practical implications in computer network optimization. Moreover, the experimentation uses a computer system with 32GB of memory, an Intel i7 processor, and the Windows 7 operating system. These specific configurations ensure the consistency and reliability of the experimental setup, enabling an equitable and precise comparison between the various algorithms. The insights derived from the study's findings, as outlined in Table 5.1, are invaluable in understanding the algorithm's performance and potential applicability in real-world network optimization scenarios. Such a comprehensive analysis is instrumental in evaluating the algorithm's competitiveness and prospective contribution to advancing computer network reliability optimization.

The results presented in Figure 5.1 from the simulations highlight a prominent trend: with an increasing number of genetic operations, the overall reliability of the network consistently improves. However, it becomes apparent that as the number of iterations for genetic operations reaches a certain threshold, the rate of improvement in network reliability gradually slows down. Several factors, such as hardware limitations and underlying constraints, contribute to this phenomenon. Eventually, the network reliability culminates at a peak value of 0.894 when the iteration count reaches 100%. Notably, fluctuations in the iteration count correlate with corresponding fluctuations in the resulting value, providing a comprehensive overview of the intricacies impacting network optimization and the challenges within the system.

The Table 5.2 illustrates a comparison of the total cost of network media for several techniques, including the Neural Network Algorithm, the Inclusion and Exclusion Principle Algorithm, the Fuzzy Neural Network Algorithm, and the Algorithm proposed in the current study. The table includes total cost values for multiple instances, highlighting the relative performance of each technique under various scenarios.

This critical stage underscores the necessity of alternative means for network optimization, specifically focusing on continuously reducing the overall cost linked to network chain testing. Analysis of the experimental results reveals an inversely proportional relationship between the fitness and satisfaction functions of the genetic improvement algorithm. Strengthening the efficiency of the fitness function and ensuring diverse cost regression under convergence conditions enables the derivation of the optimal function solution. This approach, centred on convergence and regression, significantly enhances network stability.

Moreover, integrating inclusive and exclusive principles in network calculations is crucial in stimulating network stability. The deliberate application of these principles facilitates the development of a more resilient network structure capable of withstanding diverse operational challenges and maximizing overall reliability.

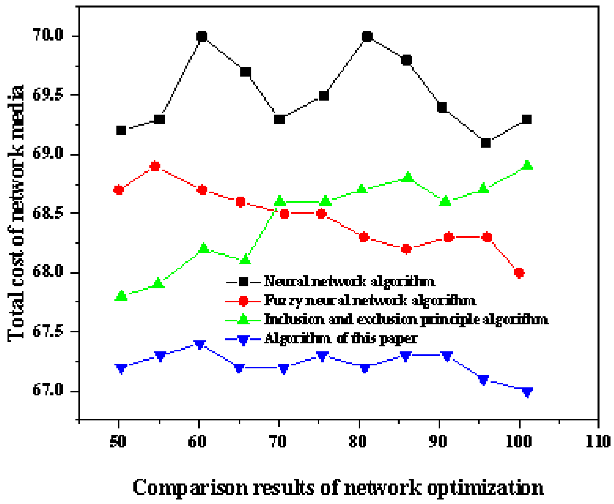

Fig. 5.1: Results of Network Optimization Comparative Analysis

6. Conclusion. The investigation of computer reliability presents a complex problem within computer development. As computers and networks increasingly converge and advance, the development of information network technology has become a fundamental requirement for the progression of network infrastructure as a whole. With an increasing reliance on information technology, computers have assumed a critical role in vital sectors such as the economy and society. Consequently, ensuring computer system reliability has become vital in guaranteeing the continuous operation of crucial sectors. Given the growing dependence on computer technology, it has become imperative to establish a robust development strategy aimed at enhancing computer reliability. By implementing a well-structured development plan, the reliability of computer systems can be substantially strengthened, ensuring the safety and stability of the entire computer infrastructure. As the reliability of computers directly impacts the overall performance and efficiency of the entire system, adopting a comprehensive approach to improving reliability for maintaining operational integrity. Acknowledging the complex nature of the challenge, researchers have incorporated sophisticated methodologies such as genetic algorithms. Researchers strive to optimize network costs by connecting the unique capabilities of genetic algorithms, thereby enhancing the overall efficiency and resilience of the computer network infrastructure. Researchers aim to establish a robust and dependable computer network framework capable of meeting the ever-evolving demands of the contemporary digital landscape by adopting an approach that simultaneously addresses multiple objectives.

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