

Application and Prospect of Artificial Intelligence in Network Communication

Jianru Han

Zhejiang University of Science and Technology Hangzhou, Zhejiang 310023

Abstract: *The rapid evolution of artificial intelligence (AI) is fundamentally reshaping the landscape of network communication. This paper, building upon the foundational work of scholars such as Han Jianru, provides a comprehensive exploration of the applications, impacts, and future prospects of AI in this critical field. We commence by elucidating the core principles of AI and machine learning (ML), detailing how key technologies—including deep neural networks (DNNs), natural language processing (NLP), and computer vision—are being leveraged to solve complex problems in communication networks. The paper subsequently offers a systematic analysis of specific application domains. These include automated network management and orchestration for self-healing and self-optimizing capabilities, intelligent routing algorithms for dynamic traffic engineering, AI-powered security frameworks for robust intrusion detection and threat mitigation, real-time quality optimization of multimedia communications, and intelligent analysis and filtering of content on social media platforms. The profound impact of AI is then critically examined, highlighting demonstrable improvements in network performance and operational efficiency, the enhancement of end-user experience through personalized services, and the creation of new avenues for business innovation. However, the integration of AI is not without significant challenges. This study also addresses critical limitations and risks, with a focused discussion on data privacy and security concerns arising from massive data collection, the ethical and moral dilemmas inherent in algorithmic decision-making (e.g., bias and transparency), and the practical technological hurdles related to computational complexity and system integration. Finally, the paper presents a forward-looking perspective on the future development of AI in network communication. We anticipate trends such as the maturation of explainable AI (XAI) for trustworthy network operations, the deep convergence of AI with next-generation networking architectures like 6G and intent-based networking, and the emergence of fully autonomous network ecosystems. This analysis concludes that the symbiotic integration of AI and network communication is an irreversible trend poised to drive the next wave of technological and economic growth, provided the associated challenges are proactively addressed.*

Keywords: Artificial Intelligence, Network Communication, Machine Learning, Automated Network Management, Intelligent Routing, Network Security, Ethical AI, 6G.

1. INTRODUCTION

With the rapid development of artificial intelligence (AI), its application in the field of network communication has shown enormous potential. This paper aims to explore the basic concepts and principles of artificial intelligence in network communication, as well as its impact on application fields such as automated network management, intelligent routing, network security, real-time communication optimization, and social media analysis. At the same time, the paper will also discuss the challenges and limitations faced by artificial intelligence in network communication, and look forward to future development and prospects. By conducting in-depth research on the application of artificial intelligence in network communication, we can better understand and respond to the current and future needs of network communication, and promote innovation and development in the field of network communication. Xie and Chen (2025) introduced InVis, an interactive neural visualization system for human-centered data interpretation [1], while Zhu (2025) proposed RAID, an intelligent detection framework for enhancing reliability in large-scale ad systems [2]. Concurrently, developer tooling evolved through Zhang (2025)'s InfraMLForge, enabling rapid LLM development and scalable deployment [3]. In generative advertising, Hu (2025) developed GenPlayAds for procedural playable 3D ad creation [4]. Healthcare AI progressed with Qin et al. (2025) optimizing deep learning models to combat ALS disease progression [5]. Natural language processing saw advancements via Jiang et al. (2025)'s knowledge-enhanced multi-task learning model for domain-specific QA [6]. Financial AI research expanded with Zeng et al. (2025) analyzing education investment's impact on household financial participation [7], while Wang (2025) addressed data sparsity through joint propensity-prediction modeling for MNAR recommendations [8]. Biomedical signal processing was surveyed by Ding and Wu (2024) in their systematic review of self-supervised learning for ECG/PPG signals [9]. For low-resource healthcare, Restrepo et al. (2024) proposed multimodal deep learning with vector embedding alignment [10]. Recommendation systems advanced with Wang and Shih (2024)'s hybrid MMOE-XGBoost model for multi-modal personalization [11]. LLM security research intensified as Fu et al. (2025) explored adversarial prompt optimization via HijackNet [12]. Financial NLP capabilities were enhanced by Zheng et al. (2025) through

FinGPT-Agent's task-adaptive optimization for report generation [13]. Finally, Weng et al. (2025) established SafeGen-X to fortify LLM security and compliance [14].

2. BASIC CONCEPTS AND PRINCIPLES OF ARTIFICIAL INTELLIGENCE IN NETWORK COMMUNICATION

Artificial Intelligence (AI) refers to the ability of computer systems to learn, reason, and make decisions by simulating human intelligence. Among them, machine learning is an important branch of artificial intelligence, which improves algorithm performance by learning patterns and patterns from data. Neural networks and deep learning are key technologies in machine learning. A neural network is a computational model that mimics the structure of the human brain's neural network, consisting of multiple interconnected nodes (called neurons). Neural networks adjust connection weights through training data to achieve classification and prediction of input data. Deep learning refers to neural networks with multiple hidden layers that can automatically extract multi-level feature representations, thereby improving the expressive power and performance of models. In network communication, natural language processing and image processing are important application areas of artificial intelligence. Natural language processing involves the understanding and generation of human language, and can be used for tasks such as speech recognition, machine translation, and sentiment analysis. Image processing involves the analysis and processing of images and videos, and can be used for tasks such as image recognition, object detection, and video content analysis. These applications can improve communication experience, enhance communication efficiency and security. The application of artificial intelligence in network communication is constantly developing, bringing new technologies and methods to network management, routing optimization, security protection, voice and video communication, and other aspects. However, the widespread application of artificial intelligence also faces challenges such as data privacy and ethical standards, which require further research and resolution. With the further development of artificial intelligence technology, we can expect to see more innovation and breakthroughs in the field of network communication.

3. THE APPLICATION FIELDS OF ARTIFICIAL INTELLIGENCE IN NETWORK COMMUNICATION

Artificial Intelligence (AI) has a wide range of applications in the field of network communication, covering automated network management, intelligent routing, network security and intrusion detection, real-time voice and video communication quality optimization, as well as social media analysis and content filtering.

3.1 Automated network management and troubleshooting

Automated network management utilizes artificial intelligence technology to monitor, configure, and optimize networks, improving the efficiency and accuracy of network management. Through data collection and analysis, automated network management systems can monitor the status and performance indicators of network devices in real time, automatically configure and troubleshoot networks. Machine learning based troubleshooting techniques can quickly identify and resolve network failures by analyzing network data and historical records, reducing manual intervention and downtime.

3.2 Intelligent routing and traffic optimization

Intelligent routing algorithms utilize artificial intelligence technology to dynamically select the optimal path for data transmission based on network conditions and service quality requirements, improving network reliability and throughput. Machine learning based traffic optimization techniques can analyze network traffic patterns, schedule and optimize traffic, and improve network bandwidth utilization and performance. These technologies can achieve intelligent allocation and dynamic adjustment of network resources, ensuring efficient data transmission and high-performance network operation.

3.3 Network Security and Intrusion Detection Based on Artificial Intelligence

Artificial intelligence plays an important role in the field of network security. Machine learning based intrusion detection systems can learn and identify abnormal behaviors in the network, timely detect and prevent network intrusion activities. By utilizing big data analysis and deep learning techniques, real-time monitoring and analysis of network traffic can be established, potential threats and security vulnerabilities can be identified, and the security and protection capabilities of the network can be improved.

3.4 Quality optimization of real-time voice and video communication

Ensuring good communication quality is crucial for user experience in real-time voice and video communication. The audio and video encoding and decoding technology based on deep learning can improve the quality and stability of real-time communication, reduce transmission delay and distortion. Through real-time monitoring and analysis of network conditions, intelligent network scheduling algorithms can achieve dynamic optimization of voice and video communication quality, including bandwidth allocation, packet loss recovery, and congestion control, ensuring smooth and clear communication.

3.5 Social media analysis and content filtering

With the popularity of social media, massive amounts of user generated content require analysis and management. By utilizing artificial intelligence technology to analyze and mine social media data, valuable information and insights can be extracted to support user recommendations and personalized services. Meanwhile, technologies based on natural language processing and image processing can intelligently filter and monitor social media content, identify and prevent the spread of harmful information, malicious behavior, and false information, and maintain a healthy and safe environment for social media.

In summary, the application areas of artificial intelligence in network communication include automated network management and troubleshooting, intelligent routing and traffic optimization, AI based network security and intrusion detection, real-time voice and video communication quality optimization, as well as social media analysis and content filtering. These applications provide more efficient, secure, and high-quality services for network communication. However, there are still some challenges in the application, such as data privacy protection, algorithm fairness, and technical implementation, which need further research and solutions. With the continuous development of artificial intelligence technology, we can expect to see more innovation and breakthroughs in network communication.

4. THE IMPACT OF ARTIFICIAL INTELLIGENCE ON NETWORK COMMUNICATION

With the development and application of Artificial Intelligence (AI) technology, it has had a profound impact on network communication. This section will focus on exploring the three main impacts of artificial intelligence in network communication: performance improvement and efficiency enhancement, improvement of user experience, and opportunities for business innovation and development.

4.1 Performance improvement and efficiency enhancement

Artificial intelligence technology provides opportunities for performance improvement and efficiency enhancement in network communication. Through the application of machine learning and deep learning algorithms, networks can intelligently analyze and make decisions based on historical data and real-time conditions, thereby optimizing the allocation and utilization of network resources. This enables the network to more intelligently manage bandwidth, process data traffic, and provide faster response speeds and more stable connection quality. Artificial intelligence technology can automate network management tasks, reduce the need for manual intervention, and improve network performance and throughput through intelligent optimization algorithms. In addition, artificial intelligence can also predict network load and demand through prediction and predictive analysis, thereby enabling resource allocation and load balancing at critical moments, improving network efficiency and responsiveness. Through performance improvement and efficiency enhancement, artificial intelligence provides a higher quality, efficient, and reliable communication experience for network communication, bringing enormous value and competitive advantage to users and enterprises.

4.2 Improvement of User Experience

The application of artificial intelligence has also brought significant improvements in user experience. By analyzing user data and behavior patterns, network communication systems can provide more personalized services. For example, recommendation systems based on artificial intelligence can recommend content and services to users based on their preferences and historical data, thereby providing a more user-friendly experience. Users no longer need to spend a lot of time and energy searching for the information they need, but can directly

receive personalized recommendations and customized services. In addition, intelligent speech recognition and natural language processing technologies enable users to interact with the network more naturally, without the need for complex commands and operations, thereby improving the interactivity and convenience between users and the network. Users can perform operations such as searching, sending messages, and making voice calls through voice commands, making the user experience more intuitive and convenient. The application of artificial intelligence makes network communication systems more intelligent and personalized, enhancing user satisfaction and participation, and bringing users a more convenient and enjoyable communication experience.

4.3 Business Innovation and Development Opportunities

Artificial intelligence has brought new business innovation and development opportunities for network communication. By delving deeper into and analyzing network data, potential business opportunities and trends can be discovered. For example, through social media analysis, businesses can understand users' needs and preferences, and then customize more precise marketing strategies. By utilizing artificial intelligence algorithms and technologies, enterprises can better understand market trends, predict user behavior and demand, and thus explore new market opportunities. In addition, AI technology has also promoted the emergence of new business models, such as intelligent Internet of Things and edge computing. These emerging business models and technologies have brought broader development prospects to the field of network communication. Enterprises can leverage artificial intelligence technology to innovate their products and services, and explore new business areas. The application of artificial intelligence has brought more business opportunities and growth space to the network communication industry, providing enterprises with more competitive advantages and development opportunities.

In summary, the impact of artificial intelligence in network communication is reflected in three aspects: performance improvement and efficiency enhancement, improvement of user experience, and opportunities for business innovation and development. Through intelligent network management and optimization, personalized services, and intelligent business innovation, artificial intelligence provides more efficient, convenient, and innovative ways for network communication.

5. CHALLENGES AND LIMITATIONS OF ARTIFICIAL INTELLIGENCE IN NETWORK COMMUNICATION

With the increasing application of artificial intelligence (AI) technology in network communication, it has also brought some challenges and limitations. This section will focus on three main challenges and limitations that artificial intelligence faces in network communication: data privacy and security, ethical and moral issues, and technical and implementation challenges.

5.1 Data Privacy and Security

Artificial intelligence requires a large amount of data for training and learning in network communication, which may include users' personal information and sensitive data. Therefore, protecting data privacy and ensuring data security are crucial. In the process of data collection, storage, and processing, appropriate security measures must be taken, such as data encryption, access control, and secure transmission, to prevent data leakage and abuse. Data privacy protection requires desensitization and anonymization of data to reduce the identification of individual identities. In addition, it is necessary to develop compliance policies and regulations to ensure the legal, transparent, and responsible use of data. Organizations and enterprises need to establish strict data privacy policies that clearly define the purpose and scope of data collection, use, and sharing to protect users' privacy rights. At the same time, strengthen regulatory and review mechanisms to ensure accountability for the legitimate use and misuse of data. By taking these measures, it is possible to effectively protect user data privacy and ensure data security, establish user trust, and promote the sustainable development of artificial intelligence in network communication.

5.2 Ethical and moral issues

The application of artificial intelligence in network communication involves a series of ethical and moral issues. For example, the fairness and bias issues of artificial intelligence algorithms require ensuring that the algorithms do not discriminate or produce unfair results. In addition, artificial intelligence also faces issues of freedom of speech and information manipulation in network content filtering and social media analysis. Therefore, it is

necessary to establish clear ethical guidelines and policies to guide the application and use of artificial intelligence, in order to ensure its maximum benefit to society and individuals.

5.3 Technical and Implementation Challenges

The application of artificial intelligence in network communication still faces some technical and implementation challenges. Firstly, the complexity of artificial intelligence algorithms and the demand for computing resources pose a challenge, requiring strong computing power and efficient algorithm design. Secondly, compatibility with existing network equipment and infrastructure is also an issue, requiring adaptation to the existing network environment and smooth transition. In addition, cultivating artificial intelligence professionals and improving the skill level of artificial intelligence applications is also a challenge that requires continuous education and training.

In summary, the application of artificial intelligence in network communication faces challenges and limitations such as data privacy and security, ethical and moral issues, as well as technical and implementation difficulties.

6. FUTURE DEVELOPMENT AND PROSPECTS

With the widespread application of artificial intelligence (AI) in network communication, there are many exciting developments and prospects in the future. This section will focus on three main aspects of future development and prospects: the further development of artificial intelligence technology, the expansion of applications in the field of network communication, and the trend of integration between artificial intelligence and network communication.

6.1 Further development of artificial intelligence technology

Artificial intelligence technology will continue to develop and innovate rapidly, driving progress in the field of network communication. With the continuous development of technologies such as deep learning, reinforcement learning, and natural language processing, artificial intelligence models will become more complex and efficient. In addition, interdisciplinary research will further promote the integration of artificial intelligence technology with other fields such as robotics, the Internet of Things, and big data analysis.

6.2 Application Expansion in the Field of Network Communication

In the future, artificial intelligence will expand into more applications in the field of network communication. In addition to traditional fields such as automated network management, intelligent routing, and network security, artificial intelligence will also be involved in a wider range of application scenarios. For example, AI based network quality monitoring and optimization will drive the improvement of real-time voice and video communication quality, while social media analysis and content filtering will help provide a safer and more beneficial network environment. In addition, artificial intelligence will also play an important role in emerging technologies such as virtual reality, augmented reality, and the Internet of Things.

6.3 The trend of integration between artificial intelligence and network communication

In the future, artificial intelligence and network communication will be more closely integrated together. Artificial intelligence will become a key driving force for network communication, providing more intelligent management and optimization capabilities for networks. For example, intelligent network resource scheduling and bandwidth management will dynamically allocate resources and provide personalized services based on real-time network conditions and user needs. In addition, AI will also combine with 5G communication, edge computing, Internet of Things and other emerging technologies to jointly promote the development and innovation of network communication.

7. CONCLUSION

This article provides an overview of the application and prospects of artificial intelligence in network communication. By introducing the basic concepts and principles of artificial intelligence, this paper explores its applications in areas such as automated network management, intelligent routing, network security, real-time communication quality optimization, and social media analysis. Meanwhile, the impact of artificial intelligence on network communication was analyzed, including performance improvement, user experience enhancement, as well as business innovation and development opportunities. However, artificial intelligence faces challenges such

as data privacy and security, ethical and moral issues, as well as technical and implementation difficulties in network communication. Finally, the further development of artificial intelligence technology, the expansion of applications in the field of network communication, and the trend of integration between artificial intelligence and network communication were discussed.

REFERENCES

- [1] Xie, Minhui, and Shujian Chen. "InVis: Interactive Neural Visualization System for Human-Centered Data Interpretation." Authorea Preprints (2025).
- [2] Zhu, Bingxin. "RAID: Reliability Automation through Intelligent Detection in Large-Scale Ad Systems." (2025).
- [3] Zhang, Yuhao. "InfraMLForge: Developer Tooling for Rapid LLM Development and Scalable Deployment." (2025).
- [4] Hu, Xiao. "GenPlayAds: Procedural Playable 3D Ad Creation via Generative Model." (2025).
- [5] Qin, Haoshen, et al. "Optimizing deep learning models to combat amyotrophic lateral sclerosis (ALS) disease progression." *Digital health* 11 (2025): 20552076251349719.
- [6] Jiang, Gaozhe, et al. "A Knowledge-Enhanced Multi-Task Learning Model for Domain-Specific Question Answering." 2025 7th International Conference on Information Science, Electrical and Automation Engineering (ISEAE). IEEE, 2025.
- [7] Zeng, Yuan, et al. "Education investment, social security, and household financial market participation." *Finance Research Letters* 77 (2025): 107124.
- [8] Wang, Hao. "Joint Training of Propensity Model and Prediction Model via Targeted Learning for Recommendation on Data Missing Not at Random." *AAAI 2025 Workshop on Artificial Intelligence with Causal Techniques*. 2025.
- [9] Ding, C.; Wu, C. Self-Supervised Learning for Biomedical Signal Processing: A Systematic Review on ECG and PPG Signals. *medRxiv* 2024.
- [10] D. Restrepo, C. Wu, S.A. Cajas, L.F. Nakayama, L.A. Celi, D.M. López. Multimodal deep learning for low-resource settings: A vector embedding alignment approach for healthcare applications. (2024), 10.1101/2024.06.03.24308401
- [11] Wang, Yang, and Kowei Shih. "Hybrid multi-modal recommendation system: Integrating mmoe and xgboost for enhanced personalization and accuracy." 2024 4th International Conference on Artificial Intelligence, Robotics, and Communication (ICAIRC). IEEE, 2024.
- [12] Fu, Lei, et al. "Adversarial Prompt Optimization in LLMs: HijackNet's Approach to Robustness and Defense Evasion." 2025 4th International Symposium on Computer Applications and Information Technology (ISCAIT). IEEE, 2025.
- [13] Zheng, Haoran, et al. "FinGPT-Agent: An Advanced Framework for Multimodal Research Report Generation with Task-Adaptive Optimization and Hierarchical Attention." (2025).
- [14] Weng, Yijie, et al. "SafeGen-X: A Comprehensive Framework for Enhancing Security, Compliance, and Robustness in Large Language Models." 2025 8th International Conference on Advanced Algorithms and Control Engineering (ICAACE). IEEE, 2025.
- [15]