Artificial Intelligence Empowers Situation Awareness in Network Information Dissemination: Value Logic, Real-World Challenges, and Practical Pathways

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Abstract: *Artificial intelligence is profoundly reshaping the governance paradigm and interactive modalities of situation awareness in network information dissemination. This paper systematically elaborates on its value logic, characterized by the shift from "experience-driven" to "data-driven" approaches and from "passive response" to "active early warning." It further provides an in-depth analysis of the real-world challenges, including institutional lag, data silos, insufficient coordination among stakeholders, and the disconnection between humans and machines. Accordingly, it proposes pathways such as improving the national governance system, deepening the application of intelligent algorithms, constructing a pluralistic coordination mechanism, and refining closed-loop human-machine governance, thereby providing solid theoretical support and a technical basis for network information governance.*

Keywords: *Artificial Intelligence; Network Information Dissemination; Situation Awareness; Governance Effectiveness*

Introduction

Amid the global wave of digital transformation, the landscape of network information dissemination is undergoing profound and unprecedented changes. Cyberspace has become a "new frontier" of national governance, and situation awareness in network information dissemination serves as a critical link for "deepening the comprehensive governance of cyberspace security." Situation awareness, a concept originating from the military domain, aims to provide decision-making support for cyberspace security governance by conducting real-time monitoring, analysis, and assessment of massive, heterogeneous, and dynamic network information. This process involves gaining insights into the generation and evolution patterns of online public opinion and identifying potential risks and threats. With the rapid development of technologies such as artificial intelligence, big data, and cloud computing, information dissemination now exhibits new characteristics, including diversification of subjects, multimodality of content, and instantaneous interaction. While these developments expand the breadth and depth of dissemination, they also present unprecedented challenges.

As a strategic technology leading the new wave of scientific and technological revolution and industrial transformation, artificial intelligence is profoundly reshaping human production and lifestyles. Its core value lies in leveraging its powerful capabilities in data processing, pattern recognition, and intelligent analysis to advance situation awareness in network information dissemination from a state of "passive defense" to one of "active early warning," and from an "experience-driven" approach to a "data-driven" paradigm. This shift aims to achieve scientific rigor, precision, and timeliness in cyberspace security governance. An in-depth study of how artificial intelligence empowers situation awareness in network information dissemination helps in the timely detection of online rumors, the prevention and mitigation of public opinion risks, and provides technical support for the dissemination of mainstream values and the forging of social consensus. Such research holds significant theoretical and practical importance for advancing the modernization of China's governance system and capabilities.

1. Value Logic

The empowerment of situation awareness in network information dissemination by artificial intelligence goes far beyond a simple replacement of "old tools" with "new technology." Its fundamental objective is to advance the modernization of the national governance system and governance capacity. Driven primarily by advanced algorithms and computing power, it employs precise early warning and the mitigation of online rumors and major public opinion risks as its practical focus. Ultimately, it serves the overarching purpose of fostering a clear and wholesome cyberspace and consolidating social consensus.

1.1 The Transformation of Governance Paradigm from "Experience-Driven" to "Data-Driven"

Situation awareness in network information dissemination serves as a critical link in advancing multi-agent collaboration and the modernization of governance capabilities. The traditional "singular governance" model, which relies on manual experience, suffers from issues such as delayed response, incomplete coverage, and subjective judgment. This model struggles to address the challenges posed by the rapidly changing nature of network information and the complex chains of risk propagation. When confronted with large-scale, organized disinformation attacks, this "experience-driven" governance model appears passive and inadequate.

Artificial intelligence leverages its powerful data processing and analytical capabilities to conduct real-time monitoring and in-depth mining of massive, heterogeneous, and dynamic network information. This enables the early detection of various social risks and the assessment of evolving situations, thereby providing a scientific basis for formulating response strategies. This approach not only enhances information processing efficiency but also propels the governance model towards a "data-driven, multi-agent collaborative" direction, preventing issues from escalating due to delayed responses.

Artificial intelligence, through deep learning and sentiment recognition, can provide dynamic early warning and decision support at various stages of public opinion evolution. This "intelligent capability embedded within the governance process" enables it to label and mitigate the sentiment impact of misinformation generated by AI during the early stages of public opinion formation. In the mid-stage, it tracks public opinion trends in real-time, makes accurate predictions, and offers response recommendations. In the later stage, it leverages media logic and algorithmic distribution to foster a positive public opinion environment and clarify "AI-generated misinformation"[1]. At the level of digital governance efficacy, artificial intelligence can also provide intelligent assistance for governance decision-making. The policy simulation and scenario deduction technologies it drives, by constructing highly realistic social system models to simulate the implementation effects of different policy options, offer decision-makers a "policy laboratory"[2], effectively reducing the blindness and uncertainty of policy implementation.

1.2 The Reconstruction of the Technical System from "Capacity-Constrained" to "Pan-Domain Awareness"

The realization of governance efficacy depends not only on institutional arrangements but also on technological capabilities and resource provision. Traditional situation awareness, constrained by algorithmic models and computing resources, struggles to conduct comprehensive and in-depth analysis of multimodal and cross-platform network information. This limitation results in insufficient capacity to handle complex information and its dissemination across different platforms.

The breakthroughs of artificial intelligence in data processing, algorithm optimization, intelligent computing power, and application scenarios have significantly expanded the technical boundaries of situation awareness. This represents not merely technological progress but also a concrete manifestation of the "capacity support logic" emphasized in governance theory, and a deepening of the coupling relationship among "technology, institutions, and capacity."

At the data level, artificial intelligence enables the efficient collection, integration, cleansing, and analysis of multi-source, heterogeneous information, extracting valuable patterns and insights to provide high-quality "data feedstock" for situation awareness. At the algorithmic level, ubiquitous perception data and computing platforms such as GPUs have driven the rapid development of artificial intelligence technologies represented by deep neural networks, substantially bridging the "technology gap" between science and application[3] and making the in-depth understanding of complex information

possible. At the computing power level, the advancement of distributed computing, cloud computing, and specialized AI chips provides the necessary computational support for processing massive datasets and running complex algorithms. At the application level, the development of multimodal artificial intelligence allows for the multi-dimensional perception and comprehension of complex information, transforming "language dialogue" into "visual communication" and "abstract thinking" into "concrete cognition." This enables a more comprehensive and accurate understanding of information content and its dissemination context, thereby enhancing the capability to predict risks.

1.3 The Evolution of Social Communication from "Information Imbalance" to "Government-Citizen Interaction"

The traditional model of social communication often struggles to effectively guide public perception and forge social consensus when confronted with phenomena such as "information cocoons," "echo chamber effects," and "group polarization." Artificial intelligence can facilitate the precise dissemination of authoritative information, enhancing communication efficiency and expanding its reach, thereby ensuring the effective supply of information. Simultaneously, by leveraging sentiment analysis and semantic understanding, it can identify and intervene in inflammatory rhetoric, thus maintaining a healthy discursive environment. Furthermore, this technology can analyze the differences and commonalities in viewpoints among different groups, aiding in the design of strategies to foster dialogue and bridge divides.

Artificial intelligence facilitates the formation of a tripartite interaction mechanism involving "government, society, and the public." The application of artificial intelligence at the societal level can assist government departments in heeding public voices, understanding public sentiment, pooling public wisdom, and addressing public concerns. This renders the governance process more inclusive and responsive, thereby enhancing the social acceptance of policies.

1.4 The Upgrade of Risk Prevention from "Passive Response" to "Active Prevention"

Artificial intelligence is actively preventing and mitigating potential risks and threats in situation awareness for network information dissemination by establishing more comprehensive ethical norms and collaborative mechanisms. This facilitates a new paradigm of risk governance characterized by the "integration of technology and management."

Traditional network governance often emphasizes ex-post accountability, whereas the integration of artificial intelligence shifts risk governance from a paradigm of "ex-post response" to one of "ex-ante prevention" and "in-process control." In the realm of privacy protection, artificial intelligence leverages technologies such as differential privacy and federated learning to fully harness the value of data while ensuring data security and individual privacy. Regarding algorithmic governance, advances in explainability research and algorithm audit technologies offer possibilities for identifying and correcting algorithmic biases. These developments promote the integration of ethics and morality throughout the entire lifecycle of artificial intelligence, fostering fairness, justice, harmony, and safety. In terms of collaborative governance, a model of multi-stakeholder collaboration is increasingly becoming the consensus in the field of artificial intelligence. This model calls for active cooperation to establish a global and comprehensive artificial intelligence governance ecosystem that spans disciplines, fields, sectors, and regions[4]. Such efforts aim to advance the formation of a widely accepted security governance framework for jointly addressing risks in cyberspace.

2. Real-World Dilemmas

Artificial intelligence has injected new dynamism into situation awareness in network information dissemination, yet its application has not completely overcome the constraints of governance dilemmas. As information grows more diverse and complex, issues such as institutional lag, technical bottlenecks, fragmented stakeholders, and human-machine disconnection have become increasingly prominent, creating a paradox of "immense potential yet limited implementation." Therefore, conducting an in-depth analysis of the dilemmas faced by artificial intelligence in empowering situation awareness in network information dissemination serves as a critical starting point for breaking through these bottlenecks and exploring practical pathways.

2.1 Structural Dilemmas: From "Institutional Lag" to "Ambiguous Rights and Responsibilities"

While the strategic value of artificial intelligence in empowering situation awareness for network information dissemination is gradually becoming evident, institutional development significantly lags behind technological advancement. Currently, the rapid evolution of online public opinion scenarios lacks the stable support of institutional safeguards in governance practices, often resulting in the predicament of having "technology without regulation." Misinformation generated by artificial intelligence threatens the public opinion ecosystem and discursive order, fragments the cognitive landscape of factual public discourse, manipulates the public orientation of discursive narratives, and undermines social trust in public opinion values[5]. When emerging forms of misinformation impact the order of public discourse, relevant policies and regulations remain confined within traditional information management frameworks, struggling to support strategic early warning and proactive response. Simultaneously, blurred governance boundaries make it difficult to clarify responsible entities. The frequent overlap of functions among enterprises, governments, and social organizations in public opinion governance, coupled with a lack of clear delineation of responsibilities and boundary constraints, can easily lead to governance vacuums and risks of buck-passing. Under conditions of insufficient strategic provision, the tension between technological empowerment and value guidance further intensifies, casting doubt on the legitimacy and sustainability of artificial intelligence in governance.

2.2 Practical Obstacles: From "Data Silos" to "Algorithmic Disparity"

Significant challenges also exist at the technical level regarding the empowerment of situation awareness in network information dissemination by artificial intelligence. Firstly, data cannot be seamlessly aggregated and shared. Information is distributed across different platforms, departments, and regions, forming "data silos" that severely constrain the learning quality and predictive capabilities of AI models. In the practice of public opinion governance, the "inaccuracy" of technical awareness among local governments leads to a weak governance mindset[6], resulting in the neglect of reasonable suggestions put forward by netizens. Although integration of data and computing power is continuously promoted at the national level, grassroots levels still exhibit deficiencies in technical adaptation and operationalization, often causing analytical results to deviate from reality. Furthermore, models remain inadequate when handling dialects, metaphors, puns, and complex contextual language, easily falling into the trap of "seeing only the trees but not the forest," which can lead to misjudgments in public opinion or delayed responses. This necessitates the integration of event knowledge graphs and network public opinion analysis pathways for emergency intelligence support. However, such cutting-edge technologies have not yet been routinely applied in most local governance practices, preventing the full potential of artificial intelligence from being realized.

2.3 Systemic Barriers: From "Fragmented Stakeholders" to "Crisis of Trust"

The lack of cohesive governance synergy among different stakeholders constitutes a major obstacle constraining situation awareness in network information dissemination. While government, enterprises, media, and the public should theoretically all participate in collaborative governance, in practice, such coordination often remains superficial. Internet platforms, driven by commercial interests and privacy considerations, maintain a cautious stance on data sharing. Simultaneously, government departments struggle to establish effective data integration mechanisms due to functional segmentation. This situation leads to a chain of risks characterized by "monitoring blind spots, cognitive disconnects, and delayed response," preventing diverse stakeholders from forming a genuine concerted force.

Public attitudes towards artificial intelligence's involvement in public opinion governance also exhibit ambivalence: "The public is more worried than optimistic about AI and lacks confidence in the government's ability to effectively regulate it"[7]. There is both anticipation for AI to enhance governance transparency and efficiency, and concern that it may evolve into a new form of surveillance tool, eroding the foundations of freedom of expression and social trust. Collaborative governance that lacks a foundation of trust often becomes merely formalistic. This not only results in inefficient resource allocation but also weakens society's overall response capacity during major public opinion events.

2.4 Operational Risks: From "Human-Machine Disconnection" to "Ethical Anomie"

At the governance model level, challenges arise from the disharmony in human-machine relations and the absence of ethical regulation. While artificial intelligence can rapidly process massive amounts of information in public opinion governance, excessive reliance on algorithmic automation may marginalize expert experience and value judgments. There is a need to guard against the tendency of technocentrism, which could lead to a governance dilemma where algorithms replace rather than assist human decision-making. In practice, decision-makers often struggle to effectively comprehend algorithmic outputs, resulting in either blind trust in or complete rejection of the results, thereby undermining the actual efficacy of human-machine collaboration.

Simultaneously, ethical and privacy risks are becoming increasingly prominent. The processes of emotion recognition and behavior prediction by artificial intelligence frequently involve vast amounts of personal information. A lack of clear ethical norms and institutional constraints can easily lead to issues such as privacy breaches, labeling, and discrimination, further exacerbating public distrust. The absence of a closed-loop governance mechanism intensifies these problems: while the monitoring and analysis stages are often emphasized, post-response feedback and improvement are chronically neglected. This results in a governance model that remains at the level of "linear reaction" rather than advancing to "cyclical optimization."

3. Practical Pathways

In response to the challenges associated with the deep application of artificial intelligence in the field of situation awareness for network information dissemination, it is necessary to construct systematic response strategies. The focus should be on effectively mitigating potential risks, optimizing the efficacy of technological application, and achieving sustainable development, thereby ensuring that artificial intelligence serves the modernization of the national governance system and governance capacity.

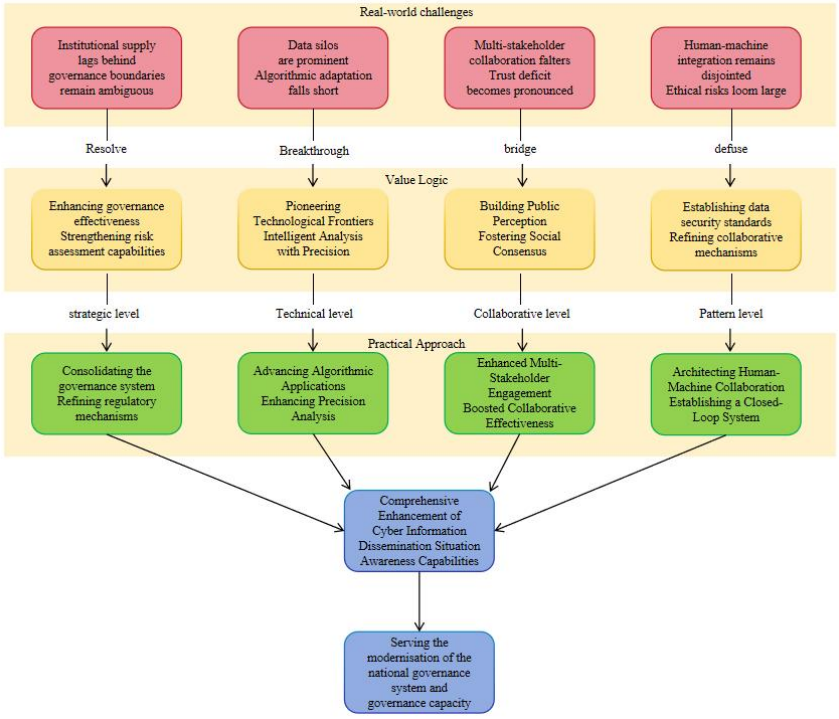

Figure 1 Practical Pathways for Artificial Intelligence Empowering Situation Awareness in Network Information Dissemination

3.1 Improving the National Governance System and the Digital Public Opinion Regulation Mechanism

In response to challenges such as the accelerated dissemination of online public opinion information,

its diverse forms, and impediments to data sharing, it is imperative to consistently embed artificial intelligence deeply into every facet of national governance. This will facilitate a digital transformation characterized by openness, transparency, and holistic intelligent governance. Government departments should innovate their governance philosophy, enhance the emphasis on and responsiveness to online public sentiment, and integrate the development of situation awareness systems into the strategic framework for modernizing the national governance system and governance capacity. It is also crucial to improve relevant laws and regulations, clearly defining the boundaries and ethical norms for the application of artificial intelligence. To address issues like the "algorithmic black box," institutional innovation is necessary to establish a "three-tier review mechanism for algorithm intervention." This mechanism would oversee the entire process of algorithm data input, model computation, and decision output, clarifying regulatory boundaries and resolving the governance paradox between technological empowerment for enhanced efficiency and the constraints of institutional inertia. Furthermore, it is essential to break down data barriers and promote information sharing and collaborative linkage across regions and departments. To mitigate the risks of misinformation from generative artificial intelligence, it is advisable to build a governance model centered on a "middle platform" as a hub. This model should fully leverage the roles of multiple stakeholders, effectively managing potential risks while unleashing technological efficacy, thereby forming a sustainable and synergistic governance force.

3.2 Deepening the Application of Intelligent Algorithms and Enabling Precise Analysis of Information Dissemination

Advancing the practical application of artificial intelligence in situation awareness hinges on the deep integration of algorithmic capabilities with the process of communication analysis and judgment. To address the vast amount of unstructured information, such as short videos, images, and audio, emerging in current cyberspace, it is essential to introduce multimodal collection and integrated analysis during the data processing stage. This involves constructing an analytical framework capable of identifying "scenes, objects, and behaviors" to achieve effective integration and unified analysis of different information types. Building on this foundation, refined sentiment classification models trained through deep learning algorithms can capture subtler and more complex emotional fluctuations within online public opinion. By dynamically tracking dissemination paths and identifying key nodes and opinion leaders during the spread of public opinion, a panoramic view of trend evolution can be formed. Furthermore, employing technologies such as distributed data lakes and federated learning enables effective sharing and joint monitoring of information across platforms and regions. This approach significantly enhances the timeliness and systematic nature of analytical outcomes, providing solid support for precise public opinion governance.

3.3 Enhancing Multi-Stakeholder Participation and Improving the Efficacy of Government-Enterprise Platform Collaboration

The "fragmentation among stakeholders" inherent in traditional public opinion governance models often leads to resource misallocation and strategic delays. Establishing a collaborative governance framework involving multiple parties, including the government, enterprises, media, society, and the public, is an inevitable choice for addressing public opinion challenges. The government needs to take the lead in platform development and promote resource integration. Enterprises should provide data and technological support. The media must play a professional guiding role. Society and the public are responsible for reflecting genuine public sentiment. It is crucial to enhance the efficacy of government-enterprise platform collaboration, preventing a situation where efforts to dismantle "public opinion information silos" fail to establish an efficient and precise co-governance mechanism with society[8]. This failure could lead to a scenario where "the governance of public affairs revolves solely around technical evaluation criteria and operates with efficiency as its central axis"[9]. It is essential to establish a sound data-sharing mechanism, promote data interoperability between the government and enterprises, and provide a solid data foundation for public opinion situation awareness. Concurrently, the government and enterprises should jointly develop intelligent technologies applicable to public opinion governance, such as large language models and AIGC tools, achieving a mutually reinforcing cycle of technological innovation and governance efficacy. A dynamically adaptive intelligent response system must be constructed, integrating mechanisms such as contingency plan matching, digital twins, and blockchain. This will facilitate the transformation of the governance model from "experience-driven" to "data- and intelligence-driven," thereby improving response efficiency. Furthermore, it is necessary to build a mature and comprehensive collaborative governance paradigm for artificial intelligence, "strengthening overall coordination and top-level design, enhancing research

on theoretical systems, improving the online public opinion supervision system, and promoting the sustainable development of online public opinion governance"[10].

3.4 Constructing a Human-Machine Collaborative Framework and a Closed-Loop Governance Operational System

Constructing a human-machine collaborative framework and a closed-loop governance operational system constitutes a critical pathway for realizing the empowerment of situation awareness in network information dissemination by artificial intelligence. The human-machine collaborative framework aims to integrate the efficient data processing capabilities of artificial intelligence with the contextual understanding, ethical judgment, and decision-making advantages of human experts. By clarifying role division—where AI handles massive information processing and preliminary analysis, while humans are responsible for in-depth interpretation and final decision-making—it effectively mitigates the risks associated with the "algorithmic black box." Ultimately, intelligent situation cognition is oriented towards human cognition; its primary function is to produce situation products that align with commanders' cognitive thinking based on efficient information processing, thereby supporting subsequent actions[11].

The closed-loop governance operational system emphasizes establishing a full-process cycle of "monitoring, analysis, response, and evaluation." This system utilizes artificial intelligence technology to achieve real-time monitoring and early warning, combines big data with expert experience for precise analysis, relies on contingency plans for coordinated response, and continuously assesses and provides feedback on governance effectiveness, forming a spiral optimization mechanism. This system represents not merely a technological integration but also a profound transformation in governance philosophy. Its core lies in positioning artificial intelligence as an auxiliary tool. Through the effective integration of human and machine intelligence, it comprehensively enhances the intelligence and precision of situation awareness, thereby providing solid support for the modernization of national governance.

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