

Multidimensional AI-Driven Transformation of Social Science Research Paradigms in Shenyang

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Abstract: The rapid development of AI technology is reshaping the research outlook of social sciences with unprecedented depth and breadth. The driving effect of AI on the research paradigms of social sciences in Shenyang is a systematic transformation process intertwined and collaboratively promoted by four-dimensional forces: methodology, data, organization, and thinking. Among them, method-driven is the instrumental foundation directly acting on the research process; data-driven is the resource core and catalyst of paradigm transformation; organization-driven is the structural guarantee for realizing paradigm transformation; and thinking-driven represents the renewal of researchers' worldviews and epistemologies. By analyzing the internal mechanisms and interactive relationships of the four-dimensional dynamics, the research paradigms are promoted to transform from "experience-driven" to "intelligence-driven", from "single-discipline" to "interdisciplinary collaboration", and from "static analysis" to "dynamic evolution".

Keywords: Artificial Intelligence; Social Science; Research Paradigm; Multidimensional Driving

1. Introduction

A paradigm is the consensus and basic views reached by scientists engaged in a specific discipline in that field, which can be regarded as the highest-level methodology and a commonly recognized worldview in a certain domain [1]. As a collection of beliefs, values, technologies and exemplars shared by a specific academic community, the research paradigm of social sciences has been evolving with the changes of the times and technological innovation. Entering the third decade of the 21st century, artificial intelligence technologies represented by big data, machine learning and deep learning are no longer just auxiliary tools for social science research, but are becoming the fundamental driving force triggering its paradigm revolution. Human society is in an unprecedented wave of technological transformation [2]. This revolution is not a simple "technology application", but a systematic reconstruction involving the whole chain and deep levels of research. For Shenyang, which is in a critical period of all-round revitalization, social science research not only bears the historical mission of providing intellectual support for major practical issues such as the transformation of old industrial bases, the construction of a national central city, and the modernization of social governance, but also faces the urgent demand for the modernization of its own research methods, data foundation, organizational model and way of thinking. Therefore, exploring how AI technology drives the multidimensional transformation of social science research paradigms in Shenyang enables social science research to more accurately diagnose the complex cruxes in the transformation of old industrial bases, more finely simulate various scenarios in the construction of a national central city, and more deeply decode the modern expression and inheritance path of profound historical and cultural deposits, so as to provide stronger, more agile and more scientific intellectual support for the all-round revitalization of Shenyang.

AI not only provides new research materials and analytical tools, but also directly embeds into the premise level of problem generation, evidence organization and knowledge dissemination [3]. The driving of AI on social science research paradigms is a multi-dimensional, interactive and collaborative systematic project, which is specifically summarized into four core dimensions: method-driven, data-driven, organization-driven and thinking-driven. Among them, method-driven is the instrumental foundation directly acting on the research process, taking AI as a problem-solving oriented enabling means [4]. The introduction of new algorithmic models provides a new path for solving complex social problems that are difficult to handle with traditional methods, making it possible to deal with

high-dimensional, non-linear and dynamic social systems, which is the technical starting point for paradigm transformation; data-driven is the resource core and catalyst of paradigm transformation. The massive, multi-source and real-time data generated by the construction of Digital Shenyang forces the innovation of research problems, designs and verification methods. The quantitative change of data scale has triggered the qualitative change of research paradigms, giving birth to a new model of data-intensive research. New methods require new data for verification, and new data need new methods for interpretation. Organization-driven is the structural guarantee for realizing paradigm transformation. The traditional research organization model with distinct disciplinary barriers and limited team size is difficult to adapt to the research needs of interdisciplinary, large-scale collaboration and high computing resource consumption in the AI era. Organization-driven promotes the transformation of team composition from single-disciplinary background to interdisciplinary composite teams; and drives corresponding changes in academic cooperation models, achievement evaluation and dissemination mechanisms; thinking-driven represents the renewal of researchers' worldviews, epistemologies and research concepts. The concepts of connectionism and complexity science contained in AI technology prompt researchers to shift from pursuing deterministic causal explanations to more understanding the correlation patterns, dynamic evolution and emergence characteristics of complex systems; from focusing on the interpretation of history and current situation to expanding to the simulation, deduction and intervention of future scenarios. The four are not isolated and parallel, but have profound logical connections and dynamic interactive relationships: new thinking gives birth to the demand for new methods and sensitivity to new data; the combination of new methods and new data produces new discoveries, further consolidating and innovating existing thinking; the effective integration and large-scale application of new thinking, new methods and new data inevitably require and promote the profound transformation of research organization models. Organizational transformation in turn provides a stable environment and resource support for the sustainable development of the former three.

2. Method-driven: Innovation of Algorithmic Toolbox from Hypothesis Verification to Model Exploration

The traditional methodological system dominated by sampling surveys, statistical regression and qualitative interviews is being expanded and deepened by an increasingly rich and powerful algorithmic toolbox, realizing the paradigm extension from hypothesis-based confirmatory analysis to model-based exploratory and generative analysis. AI has gone beyond the category of tools and become an active collaborator [5], enabling social science research in Shenyang to deal with higher-dimensional, larger-scale and more dynamically complex practical problems.

2.1 Complex Causal Inference and Policy Effect Evaluation

For a region with intensive policy practices like Shenyang, accurately evaluating the effects of various revitalization policies is crucial. Traditional methodologies are mostly posterior descriptions of real phenomena or simple causal relationship construction [6], which have limitations in the face of complex realities with multiple interactive influences and heterogeneous treatment effects. AI methods can more flexibly control high-dimensional confounding variables and identify the heterogeneity of treatment effects, that is, the differential impacts of policies on different regions, groups and enterprises, providing fine-grained basis for the subsequent precise implementation of policies.

2.2 Social Simulation and Policy "Sand Table Deduction"

Based on social simulation methods such as agent-based modeling and system dynamics, combined with AI for parameter optimization and rule learning, it becomes possible to conduct dynamic and visual simulation of complex social systems. Shenyang involves complex interactions among multiple stakeholders in promoting urban renewal, industrial transformation and social governance. Researchers can set behavioral rules and goals of different subjects, simulate the long-term evolution trends of indicators such as regional vitality, economic benefits and social satisfaction under different policy interventions, realize ex-ante "sand table deduction" of policies, and reduce trial-and-error costs.

2.3 In-depth Insight into Unstructured Text and Public Opinion Emotion

As a famous historical and cultural city with high network activity, Shenyang has massive

information about urban image, public opinion and social mentality on the Internet. Natural language processing technology, especially large language models based on Transformer architecture, sentiment analysis and topic evolution models, enables automatic and in-depth analysis of massive texts. Researchers can dynamically monitor network volume, emotional tendency and topic evolution, identify key events and issues affecting urban reputation; conduct digital mining of historical documents and local chronicles, realizing "distant reading" and "macro-analysis" of humanities research.

2.4 Spatiotemporal Big Data and Analysis of Urban Complex Systems

Using spatiotemporal big data such as mobile phone signaling, traffic checkpoints and shared bicycles, combined with technologies such as computer vision and graph neural networks, the urban spatial structure, population flow laws, functional area mixing degree and urban vitality distribution of Shenyang can be accurately depicted. For example, by analyzing multi-source spatiotemporal data, the actual commuting scope and connection intensity of Shenyang Metropolitan Area can be accurately identified, providing empirical support for transportation planning and industrial layout; the effectiveness of "Park City" construction can be evaluated, analyzing the relationship between green space accessibility and residents' usage patterns; "lost corners" of urban space can be mined, providing targeted positioning for micro-renewal.

3. Data-driven: Data-intensive Discovery from Limited Samples to Global Correlation

The multi-source heterogeneous data accumulated in Shenyang's digital transformation has reshaped the whole chain of problem posing, analysis process and knowledge output, bringing social science research into the fourth paradigm of "data-intensive scientific discovery". Data-driven means not only more data, but also a fundamental transformation of research logic.

3.1 Revolutionary Expansion and Integration of Data Sources

Shenyang's data ecosystem is becoming increasingly rich, including government data, social perception data, cultural and historical data, industrial and economic data, etc. The key challenge and opportunity of data-driven lies in cross-source integration. For example, associating enterprise electricity consumption data, freight logistics data with government approval data can more truly evaluate regional economic activity and policy effectiveness; combining scenic spot passenger flow data, social media reviews with traffic data can comprehensively evaluate the comprehensive impact of cultural and tourism activities. This requires research to shift from single data source analysis to correlation, calibration and integrated analysis of multi-source heterogeneous data.

3.2 Fundamental Transformation of Research Logic

Driven by data, research can start with exploratory analysis of massive data, discover unprecedented patterns, correlations and anomalies, and then generate new research hypotheses and theories. For example, through large-scale correlation analysis of Shenyang's annual enterprise industrial and commercial registration, cancellation and change data, as well as judicial litigation and intellectual property data, it is possible to automatically identify the life cycle characteristics of different industries, the evolution laws of enterprise clusters, and the key risk factor combinations affecting enterprise survival, giving birth to new theoretical conjectures about "the dynamics of market players in Northeast China", and enhancing the openness and innovation potential of knowledge discovery.

3.3 Improvement of Real-time Dynamic Analysis and Prediction & Early Warning Capabilities

Streaming data generated by government hotlines, social media and sensor networks makes near real-time monitoring and dynamic tracking of social phenomena possible. To study the public service demand in Shenyang, we can analyze the topic clustering and spatiotemporal distribution changes of hotline appeals in real time, and timely perceive people's livelihood pain points and risk signs; to study public security and social stability, we can conduct affective computing and risk propagation simulation based on multi-source information to realize early warning. Data-driven has shifted social science research from "retrospective analysis" to "forward-looking prediction", greatly enhancing the value of

decision-making support.

3.4 Data Governance and Ethics Become Preconditions for Research

While bringing opportunities, data-driven also poses severe challenges. Issues such as data quality, data security, privacy protection and algorithm fairness have become pre-ethical and normative issues that social science research must take seriously. When using government and enterprise data, social science research in Shenyang must establish strict mechanisms for data desensitization, privacy computing and compliant use. Research itself should also pay attention to emerging social issues such as digital divide and algorithm discrimination. Researchers are not only users of data, but also thinkers and practitioners of data governance and ethics.

4. Organization-driven: Reconstruction of Research Ecology from Disciplinary Barriers to Cross-collaboration

The profound transformation of research paradigms inevitably requires and gives birth to the adaptive adjustment of research organization models. AI-driven social science research is highly interdisciplinary, technology-intensive and collaborative, which is promoting the structural reshaping of social science research institutions, teams and cooperation networks in Shenyang, breaking resource barriers, promoting knowledge integration, and providing solid talent support for the transformation of research paradigms in the AI era.

4.1 Iterative Upgrade of Research Institutions and Platforms

The traditional organizational structure of colleges, departments and liberal arts bases is difficult to effectively support AI social science research that requires continuous computing power, shared data and composite talents. Universities and research institutions in Shenyang are evolving in two directions: first, building physical or virtual interdisciplinary research centers to break the boundaries of arts, science and engineering disciplines and form a fixed interdisciplinary research position; second, building shared infrastructure platforms, including social science big data platforms, high-performance computing platforms, and low-code AI tool platforms, to provide public data and computing power services for social science research across the city.

4.2 "Triple Aggregation" of Research Team Composition

Successful AI social science research projects increasingly rely on "triple aggregation" teams of "social science professional knowledge + data science/statistics skills + computer science/engineering technology capabilities". Social science research teams in Shenyang need to take the initiative to absorb and cultivate talents with composite backgrounds, encourage social science scholars to learn data thinking and basic programming; introduce or closely cooperate with data scientists and algorithm engineers. Effective collaboration mechanisms need to be established within the team to ensure that the problem awareness and theoretical concerns of social science can be deeply integrated with technical implementation paths.

4.3 Networking and Ecologization of Cooperation Models

Research cooperation has shifted from loose, project-based personal cooperation to more stable, in-depth and networked strategic collaboration among institutions. Specifically, it includes: "government-industry-university-research" collaboration, combining real governance needs, industrial data, technical capabilities with academic research to carry out joint research of "problem-oriented, data-supported, technology-driven and decision-serving"; cross-regional and cross-institutional alliances to share resources, standards and topics; the introduction of public science to attract citizens to participate in data annotation, information provision or plan co-creation, making the research process itself a process of social participation and consensus building.

4.4 Innovation in Academic Evaluation and Achievement Dissemination Mechanisms

AI social science research has diverse achievement forms, and the research cycle and collaboration mode are different from traditional ones, which requires corresponding adjustment of the academic

evaluation system. It is necessary to recognize the academic value of non-traditional paper achievements such as data sets, software tools and policy reports; when evaluating projects, attach importance to the interdisciplinary composition of the team and the ability to solve practical problems; in terms of achievement dissemination, actively use new forms such as interactive data visualization, dynamic reports and online simulation platforms to enhance the accessibility and influence of research achievements, and directly serve the public and decision-makers.

5. Thinking-driven: Cognitive Framework Transition from Causal Explanation to System Simulation

Thinking-driven is the core and soul of paradigm transformation, prompting social science researchers in Shenyang to actively embrace this cognitive change in the AI era, internalize complexity, relevance, dynamics and generative thinking into the basic perspective of research, so as to put forward more forward-looking, penetrating and practical research questions in the intelligent era, and truly release the huge potential of AI methods, data and organizations.

5.1 From Reductionist Thinking to Complexity Thinking

Traditional social science research tends to decompose complex social phenomena into independent variables and seek simple causal chains. AI technology, especially the ability to handle high-dimensional nonlinear systems, enables researchers to better accept and explore the essential complexity of society. For example, to study the industrial transformation of Shenyang, complexity thinking requires regarding the industrial system as a complex adaptive system dynamically coupled and co-evolved by multiple factors such as enterprises, technology, capital, policies and culture, using network science, multi-agent simulation and other methods to understand its resilience, phase transition and various possibilities of transformation paths, rather than merely attributing to a few macro factors.

5.2 From Sample Thinking to Population Thinking

Traditional research is limited by data acquisition capabilities, mainly relying on sampling surveys to infer the population through samples. Big data and AI make it possible to analyze the "population" or "near population". This promotes the shift of thinking from the inferential logic of "seeing the big from the small" to the logic of "facing the whole picture" for depiction and mining. Researchers need to think: when having nearly full-volume data, how should research questions be redefined? What is the value of "long-tail" phenomena and rare patterns in the population? This requires transcending the traditional statistical significance thinking and paying more attention to patterns and differences of practical significance.

5.3 From Static Thinking to Process Thinking

Traditional cross-sectional data or a small number of time-point data easily lead to a static and structured understanding of society. Real-time data streams and simulation technologies enable researchers to track the evolution trajectory of social phenomena from a dynamic and process perspective. The focus of thinking shifts from "what the structure is" to "how the process unfolds" and "how patterns are generated". For example, to study community governance, process thinking focuses on how residents' demands are formed, spread, interacted and evolved through online and offline networks, and finally responded to or resolved, which is a continuous dynamic process that cannot be summarized by a few static indicators.

5.4 From Interpretive Thinking to Generative and Interventional Thinking

Traditional social science takes interpretation as the core goal, aiming to understand the reasons behind phenomena. The simulation and prediction capabilities driven by AI strengthen the generative and interventional orientation of research. That is, not only being satisfied with explaining "why a certain community in Shenyang lacks vitality", but also committing to simulating how community vitality may be "generated" and changed under different intervention strategies by constructing computational models, so as to pre-compare and evaluate the effects of different intervention plans. This extends social science research from "critical" to "constructive", directly serving precise policy implementation and social design.

6. Conclusions

The driving effect of AI on the research paradigms of social sciences in Shenyang is a systematic transformation process intertwined and collaboratively promoted by four-dimensional forces: methodology, data, organization and thinking. The four are interdependent and causal, jointly pushing social science research in Shenyang from the paradigm dominated by qualitative description and traditional econometrics to a new paradigm of "intelligent social science" that focuses more on calculation, simulation, prediction and intervention, and deeply integrates data science, complexity science and various branches of social sciences. Facing the future, the multi-dimensional AI-driven social science research in Shenyang will evolve to a deeper level and wider field, specifically including: the endogenous generation of new paradigms empowered by AI, simulation becoming the core support for decision-making, the prominence of humanistic value and ethical regulations, the globalization of local knowledge and the formation of characteristic paradigms. In short, the transformation of social science research paradigms in Shenyang driven by multi-dimensional AI is both a severe challenge and a historic opportunity. By actively embracing this transformation and systematically promoting methodological innovation, data governance, organizational restructuring and thinking innovation, social science research in Shenyang will surely occupy a more important position in the territory of China's social science development and contribute irreplaceable wisdom and strength to the revival journey of this city.

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