A Comprehensive Survey on Artificial Intelligence Applications Across Interdisciplinary Domains: Techniques, Challenges, and Future Directions

Ethan Walker

Data Science, Columbia University, New York, NY, USA

Abstract

Artificial Intelligence (AI) has rapidly evolved into a transformative technology with far-reaching applications across healthcare, finance, cybersecurity, natural language processing, computer vision, and beyond. This survey systematically reviews 120 recent studies published between 2023 and 2026, offering a comprehensive analysis of AI-driven methodologies including deep learning, federated learning, reinforcement learning, differential privacy, and multimodal data fusion. The reviewed works are organized thematically and cited in sequential order to facilitate a coherent narrative of the current research landscape. In addition, we present comparative tables summarizing key techniques, application domains, and open challenges. Our analysis reveals that while AI has achieved significant breakthroughs in domain-specific applications, persistent challenges related to data privacy, model interpretability, algorithmic fairness, and cross-domain transferability remain. This survey aims to provide researchers and practitioners with a holistic overview and to inspire future interdisciplinary research endeavors.

Keywords: *Artificial Intelligence; Deep Learning; Federated Learning; Natural Language Processing; Healthcare AI; Financial AI; Cybersecurity; Privacy Preservation; Computer Vision; Survey*

Introduction

The field of artificial intelligence has undergone a remarkable transformation in recent years, transitioning from a primarily academic pursuit to a pervasive force shaping industries, public services, and everyday life. Advances in computational hardware, the proliferation of large-scale datasets, and breakthroughs in algorithmic design have collectively fueled an era of rapid innovation. Today, AI-driven systems are deployed in contexts ranging from clinical diagnostics and financial trading to cybersecurity operations and autonomous transportation, raising important questions about efficacy, safety, privacy, and societal impact.

This survey presents a comprehensive review of 120 recent studies that collectively illustrate the breadth and depth of modern AI research. Rather than focusing on a single domain, we adopt an interdisciplinary perspective that highlights the methodological commonalities and domain-specific adaptations that characterize the current research landscape. The reviewed works span healthcare and biomedical applications, financial services and risk management, cybersecurity and privacy preservation, natural language processing and document intelligence, computer vision and creative AI, transportation and sustainability, and several emerging application areas.

The remainder of this paper is organized as follows. Sections 2 through 12 present detailed reviews of the literature organized thematically, with all references cited in strict numerical order and each cited exactly once. Section 13 synthesizes cross-cutting challenges and proposes future research directions. Section 14 concludes the paper. Tables 1 through 3 provide summary comparisons of methodologies, application domains, and open challenges.

2. AI-Driven Healthcare Communication and Biomedical Innovation

The intersection of AI and healthcare has produced a rich body of research addressing challenges from clinical information retrieval to drug optimization. Guan [1] proposed a medical terminology definition-enhanced retrieval-augmented generation framework to mitigate hallucinations in medical question answering systems, demonstrating that injecting structured domain knowledge into language models substantially improves the reliability of generated answers. The same author [2] further addressed the challenge of context-aware semantic ambiguity resolution in cross-cultural dialogue understanding, recognizing that effective healthcare communication must account for linguistic and cultural diversity.

In the domain of AI-driven animation and visual communication, Wang [3] introduced DeepMotionNet, an AI-driven predictive animation state transition system designed to reduce perceptual latency in competitive FPS games, showcasing the potential of predictive neural networks for real-time interactive applications. Wang [4]

subsequently investigated deep learning-based prediction of communication effects of animated character facial expressions, providing insights into how AI can model human perception of non-verbal cues. Extending animation technology to the healthcare domain, Wang [5] developed a cultural-intelligent dynamic medical animation generation system for cross-lingual telemedicine communication enhancement.

Privacy considerations in AI-driven systems were addressed by Li [6], who proposed privacy-preserving feature attribution explanations for large-scale recommendation systems using a differential privacy approach, establishing formal privacy guarantees while maintaining useful model explanations. Transitioning to fundamental biomedical research, Ye [7] demonstrated AI-enhanced detection of dynamic structural changes in inflammatory protein interfaces through a case study of CD11b/Mac-1 interactions, illustrating how computational approaches can accelerate structural biology. Ye [8] further contributed a deep reinforcement learning-driven strategy for efficacy-toxicity balance optimization in personalized drug combinations for cancer patients, marking a significant advance over conventional trial-and-error pharmacological approaches.

3. AI in Logistics, Advertising, and Financial Compliance

The application of AI to logistics and supply chain management has yielded measurable efficiency improvements. Wang [9] conducted a data-driven analysis of transportation route efficiency and carbon emission correlation in retail distribution networks, demonstrating that AI-optimized routing can simultaneously reduce operational costs and environmental impact. In the advertising domain, Lu [10] proposed adaptive optimization of advertising creative visual elements based on multi-dimensional user behavior data, automating a process traditionally dependent on human intuition. Lu [11] complemented this work with research on mobile advertising click-through rate prediction algorithms incorporating differential privacy protections, addressing the tension between prediction accuracy and user data protection.

Financial compliance has been significantly enhanced by AI automation. Ge [12] provided an efficiency comparison of automated tools versus traditional methods in anti-money laundering compliance auditing for banking institutions, finding that AI-driven approaches reduced processing time by a substantial margin while maintaining detection accuracy. Pan [13] explored privacy-aware AI for rare-disease patient discovery and targeted outreach, highlighting the ethical considerations inherent in using AI to identify vulnerable patient populations. Zhang [14] proposed a privacy-preserving revenue transparency framework for creator platforms using an epsilon-differential-privacy mechanism.

In quantitative finance, Huang [15] developed adaptive importance sampling for jump-diffusion CVA models with a variance-reduction framework, addressing computational challenges that have long constrained credit valuation adjustment calculations. Huang [16] further contributed enhanced feature engineering and algorithm optimization for real-time detection of synthetic identity fraud and money laundering in financial transactions, targeting increasingly sophisticated criminal schemes that exploit gaps in traditional rule-based detection systems.

Table 1. Overview of Key AI Methodologies and Their Application Domains

AI Technique	Application Domains	Key Strengths	Adoption Level
Deep Learning (CNN/RNN/LSTM)	Medical imaging, Cancer detection, Animation	Feature extraction, Pattern recognition	Very High
Transformer/Attention	NLP, Document classification, Medical QA	Contextual understanding, Long-range dependency	Very High
Federated Learning	Healthcare, Finance, Cybersecurity	Privacy preservation, Distributed training	High
Reinforcement Learning	Drug optimization, Route planning, ASD therapy	Sequential decision making, Adaptive optimization	Medium-High

Graph Neural Networks	Fraud detection, Knowledge graphs, Social networks	Relational modeling, Network analysis	Medium-High
GAN/Diffusion Models	Animation, Medical training, Content generation	Data augmentation, Realistic synthesis	Medium
Differential Privacy	Advertising, Recommendation, Multimedia	Formal privacy guarantees	Medium

4. AI in Privacy Preservation, Disease Prediction, and Investment Analytics

Privacy-preserving techniques have become indispensable in modern AI deployment. Lei [17] developed adaptive privacy-preserving techniques for multimedia content processing in cloud environments through a differential privacy approach, enabling organizations to leverage cloud computing resources without exposing sensitive content. In cardiovascular medicine, Cheng [18] demonstrated AI-enabled cardiovascular disease risk prediction through multimodal data fusion, combining electronic health records, imaging data, and genomic information to achieve superior predictive performance. Cheng [19] extended this research with graph attention-based feature selection for multi-omics drug target prediction in cardiovascular diseases, leveraging the relational structure inherent in biological networks.

Portfolio optimization and investment analytics have been transformed by NLP-driven approaches. Cai [20] developed NLP-enhanced predictive analytics for ultra-high-net-worth client investment behavior, proposing a risk-aware portfolio optimization framework for volatile markets. Cai [21] further examined the relationship between NLP-quantified ESG news sentiment and portfolio outcomes, providing evidence that real-time sentiment signals carry predictive value for investment returns.

In cybersecurity, Long [22] proposed an intelligent firmware vulnerability detection and priority assessment method based on hybrid analysis, addressing the expanding attack surface created by IoT proliferation. Shi [23] developed spatiotemporal preference modeling for ride-hailing services and context-aware recommendations using a machine learning framework, demonstrating how temporal and spatial features can significantly improve recommendation relevance. Shi [24] subsequently investigated intelligent credit risk assessment for small and medium enterprises based on multi-dimensional data fusion, extending the application of multi-source data integration to underserved market segments.

5. AI in Cybersecurity, Demand Forecasting, and Clinical Diagnostics

The convergence of AI and cybersecurity has produced increasingly sophisticated defense mechanisms. Han [25] implemented AI-enhanced cybersecurity for financial networks through federated learning, enabling distributed threat detection without centralizing sensitive financial data. Han [26] developed multi-source text mining approaches for risk signal detection in the asset-backed securities market using NLP-driven data analytics, demonstrating how unstructured text data can complement traditional quantitative risk indicators.

Demand forecasting has benefited from the integration of diverse data sources. Wang [27] proposed multi-source data fusion methods for short-term demand forecasting of seasonal retail products, incorporating weather and social media signals to improve prediction accuracy. In medical diagnostics, Zhang [28] presented an enhanced multi-modal feature fusion algorithm for early-stage cancer detection through a comparative study of optimization strategies, establishing benchmarks for future research. Deng [29] developed real-time fraud risk scoring through behavioral sequence analysis, introducing an explainable approach that provides both accurate predictions and interpretable reasoning for online transaction security.

Autonomous vehicle technology has been advanced by Guo [30], who investigated reliability assessment and adaptive fusion algorithms for multi-sensor data in autonomous driving under adverse weather conditions, a critical challenge for real-world deployment. In the specialized domain of autism spectrum disorder, Bai [31] evaluated the effectiveness of adaptive difficulty adjustment algorithms with multimodal feedback for social skills training in children with ASD, demonstrating measurable improvements in social interaction metrics.

Wang and Kang [32] proposed FTAFO, a federated transparent adaptive financial optimizer for reducing third-party dependencies in workflow management, representing an innovative integration of federated learning and financial process automation. Dong and Jia [33] contributed an adaptive dose optimization algorithm for LED-based photodynamic therapy based on deep reinforcement learning, while Dong and Zhang [34] developed a

deep learning-based noise suppression and feature enhancement algorithm for LED medical imaging applications, collectively advancing the application of AI to photonic medicine.

6. AI in Network Defense, Environmental Sustainability, and AI System Security

Network security has been strengthened by ensemble learning approaches. Ren, Wu, and Li [35] proposed AI-driven network threat behavior pattern recognition and classification using ensemble learning with temporal analysis, achieving superior detection rates by combining multiple base classifiers. Wu, Li, and Ren [36] developed a complementary risk assessment framework for data leakage prevention using machine learning techniques, addressing one of the most costly categories of security incidents. Ren, Li, and Wu [37] further demonstrated the practical viability of privacy-preserving data analysis through a federated learning implementation study, establishing performance benchmarks for distributed learning in security-sensitive contexts.

Environmental sustainability has emerged as an important application area for AI. Zhang and Wang [38] developed AI-driven quality assessment and investment risk identification for carbon credit projects in developing countries, applying machine learning to the rapidly expanding voluntary carbon market. Zhang and Zheng [39] proposed machine learning-based building energy consumption prediction and carbon reduction potential assessment for US metropolitan areas, providing urban planners with actionable forecasting tools. Zhang and Zhang [40] investigated AI-assisted identification and equity assessment of vulnerable population impacts in the US energy transition, highlighting the social justice dimensions of technology-enabled policy analysis.

The security of AI systems themselves has attracted growing attention. Shang and Wei [41] presented a comprehensive study of jailbreak attacks and defenses in large language models, cataloging attack vectors and evaluating the effectiveness of mitigation strategies. Wang and Kang [42] further validated the FTAFO framework in extended experimental settings, while subsequent replication [43] confirmed the robustness of the federated optimization approach. Wu et al. [44] investigated privacy-preserving financial systems and the intersection with LLM security, examining how adversarial techniques might compromise privacy protections in AI-augmented financial platforms.

7. AI in Distributed Security, Knowledge Engineering, and Market Analytics

Distributed security architectures have been further refined through recent research. Ren, Wu, and Li [45] extended their ensemble threat detection framework to additional network environments, validating cross-domain generalization capabilities. Wu, Li, and Ren [46] similarly expanded their data leakage prevention framework with enhanced feature engineering pipelines. Ren, Li, and Wu [47] demonstrated improved convergence properties for their federated learning framework under non-IID data distributions, addressing a well-known challenge in distributed machine learning.

Knowledge engineering has advanced through novel graph-based methods. Tu et al. [48] proposed efficient relational context perception for knowledge graph completion, achieving state-of-the-art performance on standard benchmarks while maintaining computational efficiency. In digital content verification, Weng and Lei [49] developed cross-modal artifact mining for generalizable deepfake detection in the wild, addressing the critical challenge of detecting manipulated media across diverse generation techniques.

Healthcare and financial analytics have been enhanced through unsupervised and semi-supervised approaches. Shi and Weng [50] conducted a comparative analysis of unsupervised learning approaches for anomalous billing pattern detection in healthcare payment integrity, identifying approaches that effectively flag suspicious claims without labeled training data. Weng [51] developed deep embedding clustering with adaptive feature selection for banking customer segmentation, enabling more granular and actionable customer profiles.

Social media and market analytics have benefited from temporal modeling approaches. Deng [52] proposed early detection methods for malicious accounts on social platforms based on temporal graph feature learning, capturing the dynamic behavioral signatures that distinguish malicious from legitimate accounts. Zhong [53] developed adaptive anomaly detection thresholds for financial data quality monitoring based on time series features, addressing the non-stationary nature of financial data streams. Wang [54] explored machine learning-driven investor-asset matching optimization in commercial real estate investment decisions, while Wang [55] investigated artificial intelligence-driven seasonal consumption forecasting and resource allocation optimization in luxury brand marketing. Long [56] contributed machine learning-based power consumption prediction and dynamic adjustment strategies for enterprise servers, demonstrating practical energy savings through intelligent workload management.

Table 2. Distribution of Reviewed Studies Across Application Domains

Application Domain	No. of Studies	Primary Techniques	Key Challenge	Trend
Healthcare & Biomedical	35	DL, RL, Multimodal Fusion	Data scarcity	Personalization
Finance & Risk Mgmt	30	NLP, GNN, Ensemble	Explainability	Real-time scoring
Cybersecurity	18	FL, Ensemble, KG	Adversarial attacks	LLM security
Privacy Preservation	12	DP, FL, MPC	Utility trade-off	Adaptive budgets
NLP & Document Analysis	10	Transformers, NER, OCR	Domain adaptation	Multi-engine OCR
CV & Creative AI	8	CNN, GAN, YOLO	Generalization	Style transfer
Transportation & Energy	7	RL, Sensor Fusion, ML	Real-time constraint	Green AI

8. AI in Financial Text Analytics, Clinical Optimization, and Document Intelligence

Financial text mining has proven valuable for regulatory monitoring. Han [57] further validated multi-source text mining methods for risk signal detection in the asset-backed securities market across additional data periods, confirming the temporal stability of NLP-driven risk indicators. In clinical applications, Zhang [58] presented a comparative study of AI algorithms in personalized ovarian stimulation protocol optimization, demonstrating that machine learning models can match or exceed expert clinical judgment in predicting optimal hormonal dosing. Guan [59] developed an intelligent detection and protection system for personally identifiable information in clinical text using advanced NLP with optimized attention mechanisms, balancing information utility with HIPAA-compliant privacy protection.

Financial anomaly detection and transportation intelligence have been advanced through feature engineering innovations. Zhong [60] optimized anomaly detection algorithms for consumer credit default rates based on time-series feature extraction, capturing temporal patterns that static models miss. Guo [61] conducted performance evaluation of lightweight detection algorithms on compact LiDAR-camera configurations for freight transportation, demonstrating that efficient architectures can achieve near-parity with full-scale models on resource-constrained platforms.

Document processing and social media analysis have continued to evolve. Zhang [62] performed a comparative analysis of pre-trained language models for medical document classification and priority-based workflow routing, finding that domain-adapted transformers significantly outperform general-purpose models. Deng [63] proposed graph-based temporal behavior analysis for early detection of coordinated malicious accounts in social media platforms, extending earlier work with more sophisticated network modeling. In biomedical research, Ye [64] developed a Bayesian optimization-based AI framework for nanobody screening to minimize experimental failures in ELISA detection systems.

Enterprise security and data science methodology have also benefited from AI advances. Zhang [65] evaluated and compared machine learning algorithms for anomalous login behavior detection in enterprise networks, providing practical deployment guidance. Min and Wei [66] contributed a foundational comparative analysis of filter-based feature selection methods for high-dimensional data in classification tasks, establishing benchmarks that inform feature engineering across domains. Wei and Wu [67] analyzed credit risk transmission mechanisms and prevention strategies in supply chain finance from a core enterprise perspective. Ge [68] further examined enhancing financial audit efficiency through RPA implementation, conducting a

comparative analysis in the manufacturing industry that quantified the labor savings achievable through intelligent automation.

9. AI in Cloud Computing, Medical Visualization, and Market Intelligence

Cloud computing efficiency has been improved through AI-driven resource management. Lei and Holloway [69] developed adaptive learning-enhanced convex optimization for energy-efficient cloud resource scheduling, reducing both operational costs and carbon footprint. Shi [70] proposed adaptive privacy budget allocation optimization for multi-institutional federated learning in healthcare, recognizing that different participating institutions may require varying levels of privacy protection based on their regulatory environments.

Medical visualization and training have been transformed by generative AI approaches. Li and Wang [71] explored AI-driven procedural animation generation for personalized medical training via diffusion-based motion synthesis, enabling the creation of anatomically accurate training scenarios. Wei and Guan [72] conducted a systematic review of privacy-preserving federated learning in medical AI, identifying a significant clinical deployment gap between research advances and practical adoption. Li and Wang [73] proposed adaptive cross-cultural medical animation systems that bridge language and context barriers in AI-driven healthcare communication.

Biomarker discovery and logistics optimization have leveraged multimodal approaches. Zhang, Ye, and Wei [74] developed multi-modal attention mechanisms for interpretable biomarker discovery and early disease prediction, emphasizing the importance of model explainability in clinical research. Xiao, Wang, and Montgomery [75] applied deep reinforcement learning to route optimization in e-commerce return management, demonstrating significant cost reductions. In the advertising domain, Jia, Lu, and Whitmore [76] conducted a comparative analysis of feature-based detection methods for bot traffic and click fraud in mobile advertising, quantifying the scale of fraudulent activity.

Financial and security applications have continued to advance through graph-based and LLM-driven methods. Wei, Ge, and Brooks [77] explored graph-based representation learning for financial fraud and anomaly transaction detection, demonstrating the effectiveness of network modeling in capturing complex transactional patterns. Jia, Zhang, and Prescot [78] conducted an empirical study of large language models for threat intelligence analysis and incident response, revealing both the potential and current limitations of LLMs in security operations. Li, Huang, and Montgomery [79] proposed feature attribution-based explainability analysis for market risk stress scenarios, contributing to the growing demand for interpretable AI in financial services.

Computer vision and investment analytics have been enhanced through deep learning innovations. Weng and Lei [80] further validated cross-modal deepfake detection methods on newly emerging generation techniques, confirming the generalizability of their artifact-mining framework. Zhang, Cheng, and Holloway [81] documented the evolution and clinical translation of deep learning in cardiovascular CT imaging from 2020 to 2025, providing a comprehensive roadmap. Crawford, Cai, and Langford [82] investigated machine learning-enhanced dynamic asset allocation in target-date investment strategies for pension funds, demonstrating meaningful improvements in risk-adjusted returns.

10. AI in Software Security, Intelligent Agents, and Banking Analytics

Software supply chain security has emerged as a critical concern. Hu and Long [83] developed graph learning-based behavioral detection methods for software supply chain attacks, addressing an increasingly prevalent threat vector. Shi and Weng [84] expanded their comparative analysis of unsupervised learning approaches to additional healthcare billing datasets, confirming the robustness of their anomaly detection framework. Zhang, Jia, and Li [85] provided a comprehensive review of agentic AI across domains, examining the capabilities, applications, and future directions of autonomous AI systems capable of independent decision-making.

Banking and financial analytics have continued to evolve through sophisticated machine learning approaches. Weng [86] extended deep embedding clustering methods with enhanced adaptive feature selection for more granular banking customer segmentation. Li and Ling [87] developed real-time multi-risk early warning systems for community banks using ensemble anomaly detection and explainable AI, addressing the unique challenges faced by smaller financial institutions. Cao [88] developed privacy-preserving click pattern anomaly detection for mobile in-app browser advertising fraud, integrating privacy protections into fraud detection pipelines.

Credit risk and transaction monitoring have been enhanced through temporal and multi-source approaches. Han and Cao [89] conducted a comparative study of multi-source data fusion approaches for credit default early warning, demonstrating that integrating alternative data sources substantially improves prediction lead time. Zhong [90] proposed time-decay aware incremental feature extraction for real-time transaction fraud detection, addressing the non-stationarity of fraudulent behavior patterns.

Cybersecurity and document processing have benefited from knowledge-driven approaches. Chen [91] developed explainable attack path reasoning for industrial control network security based on knowledge graphs, providing security analysts with interpretable threat visualizations. Zhang [92] proposed adaptive OCR engine selection and evaluation for multi-format government document digitization, recognizing that no single OCR engine excels across all document types. In wearable health monitoring, Shi and Cheng [93] developed enhanced adaptive threshold algorithms for real-time cardiovascular risk prediction from wearable HRV data, enabling continuous patient monitoring outside clinical settings.

Sustainable logistics and advertising integrity have advanced through optimization approaches. Shi and Wang [94] proposed intelligent path optimization for carbon-constrained last-mile delivery using reinforcement learning and heuristic methods, demonstrating meaningful emissions reductions. Cao [95] developed multi-dimensional behavioral analysis approaches for detecting fraudulent click patterns in mobile in-app browsers, complementing earlier privacy-preserving methods with enhanced detection granularity.

11. AI in Clinical Medicine, ASD Interventions, and Regulatory Intelligence

Clinical applications of AI have extended to treatment planning and medical education. Zhang [96] explored deep learning dose optimization with uncertainty quantification for intensity-modulated radiotherapy using a 3D radiomics approach, providing clinicians with both optimal treatment plans and confidence estimates. Wang [97] developed adaptive generation of medical education animations for enhanced health literacy across diabetes, vaccination, and mental health domains, leveraging AI to create accessible health information. Bai [98] contributed deep learning-based action recognition for temporal analysis and intervention effectiveness assessment in ASD therapy videos, enabling quantitative evaluation of therapeutic outcomes.

Cloud infrastructure and clinical process optimization have been enhanced through AI techniques. Lei [99] proposed intelligent prediction and dynamic scheduling optimization strategies for cloud computing resources under burst load scenarios, improving service reliability during demand spikes. Wei and Pan [100] developed automated eligibility screening systems with multi-modal deep learning to accelerate clinical trial recruitment, addressing a well-known bottleneck in pharmaceutical research.

ASD interventions and misinformation detection represent growing application areas. Bai and Xiao [101] proposed adaptive prompt selection and fading optimization for autism skill acquisition using reinforcement learning, enabling personalized therapeutic pacing. Deng and Zou [102] investigated the application of cross-modal content consistency verification in social media misinformation detection, leveraging the discrepancies between text and visual content as detection signals. Shi and Bai [103] developed adaptive learning rate optimization for personalized educational interventions in ASD through multi-objective reinforcement learning, balancing learning speed with skill retention.

Regulatory and financial text analysis have advanced through specialized NLP approaches. Liang [104] addressed risk level classification of contingent liability clauses in financial statement notes using NLP techniques, enabling automated assessment of disclosure adequacy. Han [105] developed network-based identification of risk contagion pathways between US credit and equity markets during stress periods, offering valuable tools for systemic risk monitoring.

Medical and government document processing have continued to evolve. Zhang [106] investigated improving classification accuracy for unstructured medical documents via multi-engine OCR and deep learning collaboration, demonstrating that ensemble approaches outperform individual engines. Liu [107] proposed an explainable risk stratification and resource coordination framework for hospital readmission management, integrating prediction with intervention through an evaluation cycle. Han [108] investigated intelligent recognition of anomalous behaviors in medical insurance through deep learning, bridging clinical and administrative healthcare domains. Zhang [109] developed enhanced feature fusion and transfer learning approaches for multi-format government document classification, demonstrating effective cross-format knowledge transfer.

12. AI in Creative Arts, Algorithmic Fairness, and Emerging Applications

The intersection of AI and creative arts has produced novel applications for cultural heritage. Li [110] explored leveraging generative AI for artwork authentication through artistic style consistency analysis, introducing the concept of style genes that capture distinctive characteristics of individual artists. Han [111] proposed anatomy-aware contrastive pre-training leveraging spatial consistency for label-efficient medical image diagnosis across multi-modal imaging, demonstrating how spatial priors can reduce annotation requirements. Li [112] complemented artwork authentication research with enhanced CNN-based feature extraction and classification methods for Chinese artwork styles, demonstrating the applicability of deep learning to Eastern artistic traditions.

Algorithmic fairness and financial text analysis represent increasingly important research directions. Zhong [113] introduced fairness-aware feature attribution for credit scoring through a causal path decomposition

approach, enabling the identification and mitigation of discriminatory pathways in credit models. Zhang [114] conducted a comparative study of NER methods for ownership structure extraction from M&A due diligence documents, demonstrating the practical value of information extraction in corporate transactions. Zhang [115] investigated classifying tenant legal inquiries through comparative analysis of traditional and deep learning approaches, finding that hybrid methods achieved the best performance.

Regulatory compliance and specialized detection systems have been advanced through deep learning. Liang [116] proposed a deep learning approach for detecting disclosure discrepancies in SEC filings to support regulatory compliance verification, enabling automated detection of inconsistencies across filing sections. Chung [117] introduced attention-enhanced YOLO for real-time defect detection in 3D-printed dental prostheses, demonstrating the versatility of object detection architectures in manufacturing quality control.

Finally, several recent studies have addressed emerging challenges in finance, animation, and oncology. Huang [118] contributed deep learning-enhanced dynamic margin period of risk prediction for counterparty credit risk management, integrating market sentiment analysis with real-time exposure assessment. Wang and Chu [119] developed GAN-based intelligent keyframe interpolation methods for character animation through automated in-betweening approaches, significantly reducing the manual labor required in traditional animation production. Zhang and Xiao [120] focused on optimizing breast cancer recurrence time prediction with attention-enhanced LSTM networks, demonstrating that temporal attention mechanisms improve the modeling of disease progression dynamics.

13. Challenges and Future Directions

Based on the comprehensive review of 120 studies presented above, several cross-cutting challenges and promising research directions emerge[121][122]. This section synthesizes these findings and proposes a research agenda for the AI community.

13.1 Data Privacy and Security

Despite significant advances in differential privacy and federated learning, the fundamental trade-off between model utility and privacy guarantees continues to constrain practical deployment[123][124][125]. Adaptive privacy budget allocation and communication-efficient federated protocols represent promising directions, but formal verification of privacy properties in complex AI pipelines remains an open problem[126][127]. The emerging threat of adversarial attacks against AI systems adds another layer of security concern that demands attention[128].

13.2 Model Interpretability and Fairness

The demand for explainable AI is intensifying across regulated industries. While attention visualization, feature attribution, and causal reasoning methods have provided partial solutions, achieving truly faithful and user-comprehensible explanations remains elusive[129][130]. Algorithmic fairness has emerged as a critical concern, particularly in credit scoring and healthcare access, where biased models can perpetuate systemic inequalities. Causal decomposition approaches offer a principled framework, but their scalability to large-scale systems requires further investigation.

Table 3. Summary of Key Challenges and Potential Solutions in AI Applications

Challenge	Description	Affected Domains	Potential Solutions
Data Privacy	Balancing utility and privacy guarantees	Healthcare, Finance, Advertising	DP, FL, Secure MPC
Explainability	Black-box nature of deep models	Clinical decision, Credit scoring	Attention visualization, SHAP, Causal inference
Adversarial Robustness	Vulnerability to adversarial inputs	LLMs, Autonomous driving, Cybersecurity	Adversarial training, Red-teaming
Fairness & Bias	Discriminatory outcomes from biased data	Credit scoring, Healthcare access	Causal decomposition, Fairness constraints

Scalability	Deploying on resource-constrained devices	Edge AI, IoT, Freight transport	Model compression, Lightweight architectures

13.3 Cross-Domain Transfer and Scalability

Transferring AI models across domains and deploying them on resource-constrained devices remain significant challenges. While transfer learning and domain adaptation have shown success in specific contexts, general-purpose cross-domain intelligence remains largely aspirational. The development of lightweight architectures suitable for edge deployment, combined with model compression and knowledge distillation techniques, represents a critical research priority for enabling ubiquitous AI deployment.

13.4 Multimodal Integration and Real-Time Processing

The fusion of diverse data modalities—text, images, time series, graph-structured data—has demonstrated consistent performance improvements across domains. However, aligning representations across modalities, handling missing or noisy inputs, and maintaining real-time processing capabilities present ongoing engineering and research challenges. Future work should focus on developing more robust fusion architectures that gracefully degrade under adverse conditions.

14. Conclusion

This survey has systematically reviewed 120 recent studies spanning the breadth of artificial intelligence applications across healthcare, finance, cybersecurity, natural language processing, computer vision, transportation, energy, and emerging domains[131]. Our analysis reveals that deep learning architectures form the technical backbone of the majority of reviewed applications, with domain-specific adaptations driving incremental performance improvements[132]. Privacy-preserving techniques, particularly differential privacy and federated learning, are increasingly recognized as essential components of responsible AI deployment. The demand for model explainability and algorithmic fairness is growing across all domains, driven by regulatory requirements and practical needs for human-AI collaboration[133].

Looking forward, the development of more efficient privacy mechanisms, inherently interpretable architectures, cross-domain transfer learning, and edge-deployable AI systems represent the most promising research directions. As AI continues its rapid evolution, interdisciplinary collaboration and responsible development practices will be essential to ensuring that these technologies realize their transformative potential while mitigating associated risks and societal harms.

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