

A Comprehensive Survey on Artificial Intelligence Applications Across Critical Domains: Healthcare, Finance, Cybersecurity, and Beyond

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ABSTRACT

Artificial Intelligence (AI) has rapidly transformed numerous industries, from healthcare and finance to cybersecurity and sustainability. This comprehensive survey systematically reviews 120 recent studies published between 2023 and 2026, covering AI applications in medical natural language processing, intelligent content generation, privacy-preserving machine learning, biomedical discovery, financial risk management, cybersecurity, autonomous systems, document intelligence, and AI for social good. We organize these studies into thematic sections, analyze methodological innovations and cross-domain synergies, and present comparative tables summarizing key contributions. Our survey identifies critical trends including the convergence of multimodal learning, the growing adoption of federated learning and differential privacy, the rise of explainable AI, and the emergence of large language model-based applications. We conclude by discussing open challenges and future research directions.

Keywords: *Artificial Intelligence, Deep Learning, Healthcare AI, Financial AI, Privacy-Preserving Learning, Cybersecurity, NLP, Computer Vision, Survey*

1. Introduction

The past decade has witnessed an unprecedented acceleration in the development and deployment of Artificial Intelligence (AI) technologies. From clinical decision support systems to real-time fraud detection engines, AI-driven applications are fundamentally reshaping how organizations operate across virtually every sector. The convergence of increased computational power, massive data availability, and algorithmic breakthroughs has enabled intelligent systems to tackle problems of extraordinary complexity and scale.

This survey provides a comprehensive review of 120 recent publications spanning multiple critical AI application domains. Unlike previous surveys that focus on a single domain, our work adopts a cross-domain perspective, examining how methodological innovations in one field transfer to and inspire advances in others. We organize the reviewed studies into thematic sections covering language understanding, content generation, privacy-preserving computation, biomedical and healthcare AI, financial services, cybersecurity, autonomous systems, document intelligence, sustainability, and AI for social good.

The remainder of this paper is structured as follows: Sections 2 through 12 review specific application domains in a progressive narrative, with each reference cited exactly once in sequential order to facilitate traceability. Section 13 presents a cross-domain discussion, and Section 14 concludes with future directions. Five summary tables are provided throughout the paper to offer structured comparisons of methods, applications, and trends.

2. AI for Language Understanding and Content Generation

2.1 Medical NLP and Cross-Cultural Communication

Natural language processing has become a foundational technology for healthcare information systems. Guan [1] proposed a medical terminology definition-enhanced retrieval-augmented

generation framework that effectively mitigates hallucination in medical question answering, addressing a critical reliability concern for clinical deployment of large language models. Extending NLP to multilingual settings, Guan [2] developed a context-aware semantic ambiguity resolution framework for cross-cultural dialogue understanding, demonstrating the importance of cultural pragmatics in achieving accurate interpretation across linguistic boundaries.

2.2 AI-Driven Animation and Multimedia Generation

Intelligent animation generation has emerged as a rapidly advancing field bridging computer graphics and deep learning. Wang [3] introduced DeepMotionNet, an AI-driven predictive animation state transition system designed to reduce perceptual latency in competitive first-person shooter games. Wang [4] developed a deep learning-based prediction technology for evaluating the communication effectiveness of animated character facial expressions, enabling more emotionally resonant digital characters. Wang [5] further extended AI-driven animation to the healthcare domain by proposing a cultural-intelligent dynamic medical animation generation system for enhancing cross-lingual telemedicine communication.

3. Privacy-Preserving AI and Biomedical Discovery

Privacy preservation has become a paramount concern in AI system design. Li [6] developed a privacy-preserving feature attribution explanation framework for large-scale recommendation systems using differential privacy, demonstrating that meaningful model explanations can be provided without compromising individual data privacy. In biomedical research, Ye [7] developed an AI-enhanced detection system for dynamic structural changes in inflammatory protein interfaces, presenting a case study of CD11b/Mac-1 interactions. Ye [8] further contributed a deep reinforcement learning-driven strategy for optimizing the balance between efficacy and toxicity in personalized drug combinations for cancer patients.

Table 1. Overview of AI Application Domains Covered in This Survey

Section	Application Domain	Key AI Methods	Scope
2	NLP & Content Generation	RAG, Seq2Seq, GANs, Diffusion Models	Medical QA, animation, telemedicine
3-4	Privacy & Biomedical/Commerce	Differential Privacy, Deep RL, Feature Engineering	Recommendations, drug optimization, advertising
5-6	Security & Sustainability	Ensemble Learning, Federated Learning, CNN	Firmware, credit risk, AML, carbon analysis
7	LLM Security & Anomaly Detection	Knowledge Graphs, Graph Neural Networks	Jailbreak defense, social media, real estate
8-9	Clinical & Financial Intelligence	Transfer Learning, GNN, Attention Mechanisms	PII detection, credit, animation, fraud
10-11	Vision, Cyber Defense & Documents	Multi-modal Detection, OCR, Adaptive Thresholds	Deepfake, pension, ICS, wearable health
12	Clinical Research & Regulatory AI	Multi-modal DL, Contrastive Learning, NER	Trials, ASD, SEC compliance, artwork

4. AI in Commerce, Finance, and Healthcare Analytics

4.1 Supply Chain, Advertising, and Financial Compliance

Wang [9] conducted a data-driven analysis of transportation route efficiency and its correlation with carbon emissions in retail distribution networks, providing actionable insights for greener logistics. Lu [10] proposed an adaptive optimization framework for advertising creative visual elements leveraging multi-dimensional user behavior data. Lu [11] developed a mobile

advertising click-through rate prediction algorithm incorporating differential privacy to balance prediction accuracy with user data protection.

Ge [12] conducted a rigorous efficiency comparison of automated tools versus traditional methods in anti-money laundering compliance auditing for banking institutions. Pan [13] demonstrated how privacy-aware AI can facilitate rare-disease patient discovery and targeted outreach while preserving patient confidentiality. Zhang [14] designed a privacy-preserving revenue transparency framework for creator platforms using epsilon-differential privacy.

4.2 Financial Risk, Privacy, and Cardiovascular AI

Huang [15] developed an adaptive importance sampling framework for jump-diffusion credit valuation adjustment with variance reduction. Huang [16] proposed enhanced feature engineering and algorithm optimization for real-time detection of synthetic identity fraud and money laundering. Lei [17] contributed adaptive privacy-preserving techniques for multimedia content processing in cloud environments.

Cheng [18] developed a multimodal data fusion approach for cardiovascular disease risk prediction, integrating clinical, imaging, and genetic markers. Cheng [19] advanced drug target identification through graph attention-based feature selection for multi-omics data in cardiovascular diseases.

4.3 Financial NLP

Cai [20] developed NLP-enhanced predictive analytics for ultra-high-net-worth client investment behavior with risk-aware portfolio optimization in volatile markets. Cai [21] further explored how NLP-quantified ESG news sentiment signals impact portfolio outcomes through real-time analysis.

5. AI in Security, Risk Assessment, and Intelligent Systems

5.1 Firmware Security and Mobility Intelligence

Long [22] developed an intelligent firmware vulnerability detection and priority assessment method based on hybrid analysis combining static and dynamic techniques. Shi [23] proposed a spatiotemporal preference modeling framework for ride-hailing services with context-aware recommendations. Shi [24] contributed an intelligent credit risk assessment framework for small and medium enterprises based on multi-dimensional data fusion.

5.2 Cybersecurity and Financial Text Mining

Han [25] developed an AI-enhanced cybersecurity framework for financial networks using federated learning implementation. Han [26] proposed a multi-source text mining approach for risk signal detection in the asset-backed securities market using NLP-driven analytics.

5.3 Retail Forecasting, Cancer Detection, and Autonomous Systems

Wang [27] developed a multi-source data fusion approach for short-term demand forecasting of seasonal retail products, integrating weather and social media signals. Zhang [28] presented an enhanced multi-modal feature fusion algorithm for early-stage cancer detection through a comparative study of optimization strategies. Deng [29] proposed a real-time fraud risk scoring system through behavioral sequence analysis with emphasis on explainability for online transaction security.

Guo [30] developed a reliability assessment and adaptive fusion algorithm for multi-sensor data in autonomous driving under adverse weather conditions. Bai [31] evaluated the effectiveness of adaptive difficulty adjustment algorithms with multimodal feedback for social skills training in children with Autism Spectrum Disorder. Wang and Kang [32] developed FTAFO, a federated transparent adaptive financial optimizer for reducing third-party dependencies in workflow management.

Table 2. Summary of Privacy-Preserving Techniques Across Application Domains

Privacy Technique	Application Domain	Key Advantage	Representative Author
Differential Privacy	Recommendation Systems	Formal privacy guarantees with model explainability	Li (2025)
Differential Privacy	Mobile Advertising	User data protection in CTR prediction	Lu (2025)
Differential Privacy	Creator Platforms	Revenue transparency without individual exposure	Zhang (2025)
Differential Privacy	Cloud Multimedia	Privacy for multimedia content processing	Lei (2025)
Federated Learning	Financial Cybersecurity	Decentralized threat detection	Han (2025)
Federated Learning	Network Security	Cross-organizational collaboration	Ren et al. (2024)
Federated Learning	Healthcare	Multi-institutional privacy-preserving research	Shi (2024)
Federated Learning	Medical AI (Review)	Clinical deployment gap analysis	Wei & Guan (2024)
Privacy-Aware Outreach	Rare Disease	Patient discovery with confidentiality	Pan (2024)
Privacy-Preserving Finance	Financial Systems	Regulatory compliance with analytical utility	Wu et al. (2025)

6. AI in Medical Technology, Network Defense, and Sustainability

6.1 LED-Based Medical Applications

Dong and Jia [33] developed an adaptive dose optimization algorithm for LED-based photodynamic therapy using deep reinforcement learning, enabling real-time treatment parameter adjustment. Dong and Zhang [34] contributed a deep learning-based noise suppression and feature enhancement algorithm for LED medical imaging applications.

6.2 Network Threat Detection and Federated Privacy

Ren et al. [35] proposed an AI-driven ensemble learning approach with temporal analysis for network threat behavior pattern recognition and classification. Wu et al. [36] developed a risk assessment framework for data leakage prevention using machine learning techniques. Ren et al. [37] presented a practical implementation study of privacy-preserving data analysis using federated learning, addressing deployment challenges in distributed environments.

6.3 AI for Environmental Sustainability

Zhang and Wang [38] developed an AI-driven quality assessment and investment risk identification framework for carbon credit projects in developing countries. Zhang and Zheng [39] proposed a machine learning-based building energy consumption prediction model with carbon reduction potential assessment for US metropolitan areas. Zhang and Zhang [40] applied AI to identify and assess the equity impacts on vulnerable populations during the US energy transition.

7. Emerging AI Paradigms: LLM Security, Knowledge Systems, and Cross-Domain Detection

7.1 Large Language Model Security and Financial Optimization

Shang and Wei [41] conducted a comprehensive study of jailbreak attacks and defenses in LLMs, mapping the evolving threat landscape. Wang and Kang [42] extended the FTAFO framework by analyzing its performance across diverse financial workflow scenarios, while their subsequent work [43] provided comprehensive benchmarking validation. Wu et al. [44] investigated privacy-preserving approaches for financial systems, integrating differential privacy and federated learning to meet regulatory requirements.

7.2 Network Security Validation and Knowledge Systems

Ren et al. [45] validated their ensemble learning approach for network threat detection across additional environments. Wu et al. [46] extended their data leakage prevention framework to cover emerging threat vectors. Ren et al. [47] further demonstrated the scalability of federated learning-based privacy-preserving analysis across heterogeneous institutional settings. Tu et al. [48] developed an efficient relational context perception method for knowledge graph completion, contributing to comprehensive knowledge representations underpinning numerous AI applications.

7.3 Deepfake Detection, Billing Anomalies, and Customer Intelligence

Weng and Lei [49] developed a cross-modal artifact mining approach for generalizable deepfake detection in the wild. Shi and Weng [50] conducted a comparative analysis of unsupervised learning approaches for anomalous billing pattern detection in healthcare payment integrity. Weng [51] proposed deep embedding clustering with adaptive feature selection for banking customer segmentation.

7.4 Social Media Analysis, Financial Monitoring, and Domain Applications

Deng [52] proposed an early detection system for malicious accounts on social platforms based on temporal graph feature learning. Zhong [53] developed an adaptive anomaly detection threshold for financial data quality monitoring based on time series features. Wang [54] applied machine learning to investor-asset matching optimization in commercial real estate investment decisions.

Wang [55] leveraged AI for seasonal consumption forecasting and resource allocation optimization in luxury brand marketing. Long [56] addressed machine learning-based power consumption prediction and dynamic adjustment strategies for enterprise servers. Han [57] validated multi-source text mining approaches for risk signal detection across additional asset-backed securities market segments. Zhang [58] conducted a comparative study of AI algorithms for personalized ovarian stimulation protocol optimization.

Table 3. Comparative Summary of AI-Based Fraud and Anomaly Detection Methods

Application	AI Technique	Key Innovation	Author (Year)
Synthetic Identity Fraud	Feature Engineering + ML	Real-time detection pipeline	Huang (2025)
Transaction Fraud Scoring	Behavioral Sequence Analysis	Explainable risk scoring	Deng (2025)
AML Compliance	Automated Auditing Tools	Efficiency over traditional methods	Ge (2025)
Malicious Social Accounts	Temporal Graph Learning	Early coordinated detection	Deng (2025)
Financial Data Quality	Time-Series Anomaly Detection	Adaptive threshold monitoring	Zhong (2025)

Healthcare Billing	Unsupervised Learning	Anomalous pattern identification	Shi & Weng (2024)
Click Fraud (Mobile)	Feature-Based Detection	Bot traffic identification	Jia et al. (2024)
Financial Graph Fraud	Graph Representation Learning	Relational pattern detection	Wei et al. (2024)
Insurance Anomaly	Deep Learning	Behavior recognition in claims	Han (2025)
Transaction Fraud	Time-Decay Feature Extraction	Incremental feature updates	Zhong (2024)

8. Intelligent Systems for Clinical, Financial, and Computing Applications

8.1 Clinical Text Processing and Credit Intelligence

Guan [59] developed an advanced NLP approach with optimized attention mechanisms for intelligent detection and protection of personally identifiable information in clinical text. Zhong [60] optimized anomaly detection algorithms for consumer credit default rates based on time-series feature extraction.

8.2 Autonomous Perception and Document Analysis

Guo [61] evaluated the performance of lightweight detection algorithms on compact LiDAR-camera configurations for freight transportation. Zhang [62] conducted a comparative analysis of pre-trained language models for medical document classification and priority-based workflow routing.

8.3 Social Media Security and Biomedical Screening

Deng [63] developed a graph-based temporal behavior analysis system for early detection of coordinated malicious accounts in social media platforms. Ye [64] proposed a Bayesian optimization-based AI framework for nanobody screening that minimizes experimental failures in ELISA detection systems.

8.4 Enterprise Security and Feature Engineering

Zhang [65] evaluated and compared machine learning algorithms for anomalous login behavior detection in enterprise networks. Min and Wei [66] conducted a comparative analysis of filter-based feature selection methods for high-dimensional data in classification tasks, contributing foundational methodological insights.

8.5 Financial Systems and Cloud Computing

Wei and Wu [67] analyzed credit risk transmission mechanisms and prevention strategies in supply chain finance from a core enterprise perspective. Ge [68] examined enhancing financial audit efficiency through RPA implementation in the manufacturing industry. Lei and Holloway [69] proposed adaptive learning-enhanced convex optimization for energy-efficient cloud resource scheduling. Shi [70] addressed adaptive privacy budget allocation optimization for multi-institutional federated learning in healthcare.

9. AI for Medical Communication, Financial Integrity, and Threat Intelligence

9.1 Medical Animation and Federated Learning Review

Li and Wang [71] contributed AI-driven procedural animation generation for personalized medical training via diffusion-based motion synthesis. Wei and Guan [72] provided a systematic review of privacy-preserving federated learning in medical AI, identifying the clinical deployment gap. Li and Wang [73] developed an adaptive cross-cultural medical animation framework bridging language and contextual barriers in AI-driven healthcare communication.

9.2 Biomarker Discovery and E-Commerce Optimization

Zhang et al. [74] leveraged multi-modal attention mechanisms for interpretable biomarker discovery and early disease prediction. Xiao et al. [75] applied deep reinforcement learning for route optimization in e-commerce return management, addressing environmental and economic costs of product returns.

9.3 Advertising Fraud, Financial Fraud, and AI Security

Jia et al. [76] conducted a feature-based detection analysis of bot traffic and click fraud in mobile advertising. Wei et al. [77] applied graph-based representation learning for financial fraud and anomaly transaction detection. Jia et al. [78] conducted an empirical study evaluating large language models for threat intelligence analysis and incident response. Li et al. [79] contributed feature attribution-based explainability analysis for market risk stress scenarios.

Table 4. Summary of Healthcare AI Applications and Clinical Impact

Healthcare Application	AI Method	Clinical Impact	Author (Year)
Medical QA Hallucination	RAG with Terminology Enhancement	Improved clinical reliability	Guan (2025)
Protein Interface Analysis	Deep Learning Structural Biology	Drug target identification	Ye (2025)
Cancer Drug Combination	Deep Reinforcement Learning	Personalized treatment plans	Ye (2025)
Cardiovascular Risk	Multimodal Data Fusion	Early risk stratification	Cheng (2025)
Early Cancer Detection	Multi-modal Feature Fusion	Improved early diagnosis	Zhang (2025)
Photodynamic Therapy	RL-based Dose Optimization	Real-time treatment adjustment	Dong & Jia (2025)
Nanobody Screening	Bayesian Optimization	Reduced experimental failure	Ye (2025)
Clinical PII Detection	Attention-based NLP	Automated de-identification	Guan (2025)
Federated Medical AI	Federated Learning Review	Clinical deployment guidance	Wei & Guan (2024)
Biomarker Discovery	Multi-modal Attention	Interpretable early prediction	Zhang et al. (2024)

10. Advanced Detection, Investment Optimization, and Cyber Resilience

10.1 Deepfake Detection and Medical Imaging

Weng and Lei [80] further validated their cross-modal artifact mining framework for deepfake detection across diverse generation methods and compression conditions. Zhang et al. [81] surveyed the evolution, trends, and clinical translation of deep learning in cardiovascular CT imaging from 2020 to 2025.

10.2 Investment Strategies and Supply Chain Security

Crawford et al. [82] applied machine learning to enhance dynamic asset allocation in target-date investment strategies for pension funds. Hu and Long [83] developed a graph learning-based behavioral detection system for software supply chain attacks.

10.3 Healthcare Analytics and Agentic AI

Shi and Weng [84] extended their comparative analysis of unsupervised learning for anomalous billing pattern detection to additional healthcare payment scenarios. Zhang et al. [85] provided a comprehensive review of agentic AI across domains, examining capabilities, applications, and future directions of autonomous AI systems.

10.4 Banking, Risk Warning, and Fraud Detection

Weng [86] further validated deep embedding clustering approaches for banking customer segmentation across different market conditions. Li and Ling [87] developed a real-time multi-risk early warning system for community banks using ensemble anomaly detection and explainable AI. Cao [88] developed a privacy-preserving click pattern anomaly detection system for mobile in-app browser advertising fraud.

Han and Cao [89] conducted a comparative study of multi-source data fusion approaches for credit default early warning. Zhong [90] designed a time-decay aware incremental feature extraction method for real-time transaction fraud detection. Chen [91] proposed an explainable attack path reasoning framework for industrial control network security based on knowledge graphs.

11. Document Intelligence, Health Monitoring, and Resource Optimization

11.1 Document Digitization and OCR

Zhang [92] addressed the challenge of adaptive OCR engine selection and evaluation for multi-format government document digitization, developing a framework that automatically selects the most appropriate OCR engine based on document characteristics.

11.2 Wearable Health and Green Logistics

Shi and Cheng [93] developed enhanced adaptive threshold algorithms for real-time cardiovascular risk prediction from wearable heart rate variability data. Shi and Wang [94] proposed an intelligent path optimization system for carbon-constrained last-mile delivery using reinforcement learning and heuristic approaches.

11.3 Advertising Analysis, Radiotherapy, and Medical Education

Cao [95] examined the detection of fraudulent click patterns in mobile in-app browsers through multi-dimensional behavioral analysis. Zhang [96] applied deep learning to dose optimization with uncertainty quantification for intensity-modulated radiotherapy using 3D radiomics. Wang [97] proposed an adaptive generation approach for medical education animations to enhance health literacy for diabetes, vaccination, and mental health topics. Bai [98] developed deep learning-based action recognition for temporal analysis and intervention effectiveness assessment in ASD therapy videos.

11.4 Cloud Computing Optimization

Lei [99] developed an intelligent prediction and dynamic scheduling optimization strategy for cloud computing resources under burst load scenarios, enabling platforms to maintain service quality during demand spikes.

12. AI for Clinical Research, Social Good, and Regulatory Compliance

12.1 Clinical Trial Acceleration and Autism Interventions

Wei and Pan [100] demonstrated how automated eligibility screening with multi-modal deep learning can significantly accelerate clinical trial recruitment. Bai and Xiao [101] proposed a reinforcement learning approach for adaptive prompt selection and fading optimization in autism skill acquisition.

12.2 Misinformation Detection and Educational AI

Deng and Zou [102] investigated the application of cross-modal content consistency verification for social media misinformation detection. Shi and Bai [103] developed an adaptive learning rate

optimization framework for personalized educational interventions in ASD using multi-objective reinforcement learning.

12.3 Financial NLP and Risk Network Analysis

Liang [104] proposed risk level classification of contingent liability clauses in financial statement notes using NLP techniques. Han [105] analyzed network-based identification of risk contagion pathways between US credit and equity markets during stress periods.

12.4 Medical and Government Document Processing

Zhang [106] improved classification accuracy for unstructured medical documents through multi-engine OCR and deep learning collaboration. Liu [107] proposed an explainable risk stratification and resource coordination framework for hospital readmission management. Han [108] developed an intelligent recognition system for anomalous behaviors in medical insurance through deep learning. Zhang [109] proposed enhanced feature fusion and transfer learning for multi-format government document classification.

12.5 Art Authentication and Medical Image Analysis

Li [110] proposed leveraging generative AI for artwork authentication through artistic style consistency analysis, introducing the concept of style genes for computational art forensics. Han [111] developed anatomy-aware contrastive pre-training for label-efficient medical image diagnosis across multi-modal imaging. Li [112] enhanced CNN-based feature extraction and classification for Chinese artwork styles.

12.6 Fairness, Legal AI, and Regulatory Compliance

Zhong [113] developed a fairness-aware feature attribution approach for credit scoring using causal path decomposition. Zhang [114] conducted a comparative study of named entity recognition methods for ownership structure extraction from M&A due diligence documents. Zhang [115] examined the classification of tenant legal inquiries using both traditional and deep learning approaches.

12.7 Advanced Financial, Manufacturing, and Medical Prediction

Liang [116] developed a deep learning approach for detecting disclosure discrepancies in SEC filings for regulatory compliance verification. Chung [117] proposed an attention-enhanced YOLO model for real-time defect detection in 3D-printed dental prostheses. Huang [118] developed a deep learning-enhanced dynamic margin period of risk prediction framework for counterparty credit risk management. Wang and Chu [119] proposed a GAN-based intelligent keyframe interpolation method for character animation. Zhang and Xiao [120] optimized breast cancer recurrence time prediction using attention-enhanced LSTM networks.

Table 5. Cross-Domain AI Trends Identified in This Survey

Cross-Domain Trend	Description	Example Domains	Representative Authors
Multimodal Fusion	Integrating heterogeneous data sources for unified analysis	Healthcare, Finance, Autonomous Driving	Cheng, Zhang C., Guo
Federated Learning	Distributed training preserving data locality	Healthcare, Finance, Security	Han, Ren et al., Shi
Explainable AI	Providing interpretable model predictions	Finance, Healthcare, Security	Deng, Li et al., Liu
Fairness-Aware AI	Mitigating algorithmic bias via causal analysis	Credit Scoring, Energy Policy	Zhong, Zhang D.

Graph Neural Networks	Modeling relational structures in complex systems	Fraud, Knowledge Graphs, ICS	Tu et al., Wei et al., Chen
LLM Applications	Leveraging large language models for domain tasks	Security, Medical QA, Finance	Shang & Wei, Guan, Jia et al.
Reinforcement Learning	Adaptive optimization for sequential decisions	Treatment, Delivery, Education	Ye, Dong & Jia, Bai & Xiao
Differential Privacy	Formal privacy guarantees for data analysis	Advertising, Platforms, Cloud	Li, Lu, Lei

13. Discussion and Future Directions

This survey has reviewed 120 recent studies spanning the full breadth of AI applications across healthcare, finance, cybersecurity, privacy preservation, NLP, computer vision, transportation, sustainability, advertising, and social welfare. Several cross-cutting observations emerge from this analysis[121][122][123].

First, multimodal learning represents the most significant methodological trend across domains. Studies in healthcare, finance, and autonomous driving all demonstrate that integrating heterogeneous data sources yields superior performance[124][125]. However, the computational and engineering challenges of multimodal fusion remain substantial, particularly when combining data modalities with fundamentally different statistical properties[126][127].

Second, the tension between model performance and privacy preservation continues to drive innovation in federated learning and differential privacy. While significant progress has been reported, the practical deployment gap remains a concern, particularly in healthcare settings where data heterogeneity across institutions can degrade federated model performance[128][129].

Third, explainability and fairness have evolved from desirable properties to essential requirements[130]. The regulatory landscape increasingly demands meaningful explanations for AI decisions, and growing awareness of algorithmic bias necessitates systematic approaches to fairness-aware design[131].

Fourth, the security of AI systems themselves has emerged as a critical frontier. As LLMs and autonomous AI agents become integral to enterprise operations, securing these systems against adversarial attacks becomes paramount.

Looking forward, promising directions include more efficient multimodal architectures, communication-efficient federated learning, standardized fairness evaluation frameworks, AI-driven sustainability solutions, and responsible deployment of agentic AI systems.

14. Conclusion

This comprehensive survey has systematically reviewed the state of AI applications across twelve major domains, synthesizing insights from 120 recent publications. The breadth of the reviewed work demonstrates that AI has matured from a collection of isolated techniques into an interconnected ecosystem of technologies capable of addressing complex, multi-faceted challenges[132]. As the field continues to advance, the convergence of methodological innovation, cross-domain knowledge transfer, and responsible AI principles will be essential for realizing the full transformative potential of artificial intelligence while safeguarding individual rights and societal values[133].

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