From Capability Migration to Value Upgrade: The Evolutionary Path of AI Cross-Domain Innovation (2022-2026)

Abstract

Artificial intelligence (AI) cross-domain innovation follows a distinct evolutionary path: starting with technical capability migration (adapting AI methods from one domain to another), progressing through scenario reconstruction (redefining application contexts to fit cross-domain needs), and culminating in value upgrade (creating new value that transcends single-domain boundaries). This review synthesizes 9 key studies (2022-2026) to map this three-stage evolutionary path, analyzing how AI evolves across healthcare, quantum science, digital commerce, cybersecurity, and finance. Findings reveal that: capability migration lays the technical foundation (e.g., LSTM from NLP to finance, hybrid architectures from computer vision to healthcare), scenario reconstruction aligns AI with cross-domain contexts (e.g., redefining data sharing as compliant collaboration in digital commerce), and value upgrade delivers systemic impact (e.g., risk-cost balance in cybersecurity, inclusive innovation for SMEs). This evolutionary framework offers a dynamic perspective on AI's cross-domain expansion, guiding researchers to design evolvable AI systems and practitioners to leverage AI's transformative potential beyond single-domain applications.

1 Introduction

AI's cross-domain impact is not a static achievement but a dynamic evolutionary process [1][9]. For example, LSTM models initially developed for natural language processing (NLP) migrate to finance (capability migration) [9], are reconstructed to fit time-series financial forecasting scenarios (scenario reconstruction), and ultimately upgrade value by enabling more robust portfolio optimization than traditional financial models (value upgrade). Similarly, federated learning originally designed for privacy-preserving data analysis migrates to digital commerce (capability migration) [3][8], is reconstructed to fit cross-channel marketing and creator monetization scenarios (scenario reconstruction), and upgrades value by balancing privacy, collaboration, and inclusivity (value upgrade). However, existing research often views cross-domain AI as a one-time application rather than an evolutionary journey [2][7]. This review addresses this gap by synthesizing recent literature (2022-2026) to unpack the "capability migration-scenario reconstruction-value upgrade" evolutionary path, providing a dynamic understanding of how AI expands across domains and creates transformative value.

2 The Three-Stage Evolutionary Path of Cross-Domain AI

2.1 Stage 1: Capability Migration – Adapting Technical Core Across Domains

Capability migration is the foundational stage of cross-domain AI, involving the transfer of AI's technical core (algorithms, architectures, infrastructures) from a native domain to a target domain. This migration is not a simple copy-paste but a targeted adaptation to the target domain's technical requirements. In healthcare, the technical core of computer vision (feature extraction, segmentation algorithms) migrates from general image processing to medical imaging [1]. Chang et al. [1] adapted path aggregation modules (native to 2D computer vision) to 3D medical image processing and integrated dual attention mechanisms (originally for sequential data) to enhance small lesion detection—migrating and customizing computer vision capabilities to fit healthcare's technical needs. In finance, NLP's LSTM model (native to language sequence analysis) migrates to financial time-series prediction [9]. Li and Liu [9] adjusted LSTM's sequence window sizes and activation functions to adapt to the volatility and periodicity of financial data—migrating NLP's sequential processing capability to finance's technical context. In quantum science, unsupervised learning (native to unlabeled data analysis in various fields) migrates to quantum system modeling [2]. Wu et al. [2] customized unsupervised learning algorithms to handle high-dimensional, non-linear quantum data—migrating the core capability of unlabeled data pattern extraction to quantum science's technical requirements. Capability migration thus provides the technical building blocks for cross-domain AI, ensuring that AI's core strengths are adapted to the target domain's unique technical constraints.

2.2 Stage 2: Scenario Reconstruction – Redefining Application Contexts for Cross-Domain Fit

Scenario reconstruction is the intermediate stage where migrated technical capabilities are aligned with the target domain's practical application contexts, redefining how AI interacts with users, workflows, and business objectives. This stage answers: "How can migrated technical capabilities be embedded into the target domain's real-world scenarios?" In digital commerce, federated learning's technical capability (privacy-preserving data collaboration) migrates from general data sharing to cross-channel marketing and SME adoption scenarios [3][7][8]. Yi [3] reconstructed the scenario from "data sharing" to "compliant cross-channel collaboration," designing a federated and differentially private framework that fits retailers' need to collaborate without violating privacy regulations. Yi [7] further reconstructed the scenario for SMEs, redefining "AI adoption" as "accessible multi-tenant integration"—building a standardized API infrastructure that fits small businesses' resource-constrained scenarios. In cybersecurity, reinforcement learning (migrated from decision-making scenarios in robotics/ gaming) is reconstructed to fit microservice vulnerability management [4][5]. Zhou [4] redefined the scenario from "single-agent risk prediction" to "multi-stakeholder patch planning," using multi-agent reinforcement learning (MARL) to align IT teams, security vendors, and business units—reconstructing the scenario to fit cybersecurity's collaborative decision-making context. In healthcare, migrated computer vision capabilities are reconstructed to fit clinical diagnosis scenarios [1]. Chang et al. [1] designed PDU-Net's output to be compatible with radiologists' workflow, redefining "image segmentation" as "clinical decision support"—ensuring the migrated technical capability fits healthcare's patient-care scenario. Scenario reconstruction thus bridges the gap between technical migration and practical application, ensuring that AI's technical strengths are directed toward the target domain's real-world needs.

2.3 Stage 3: Value Upgrade – Creating Systemic Impact Beyond Single-Domain Boundaries

Value upgrade is the final stage where migrated technical capabilities and reconstructed scenarios combine to create new value that transcends what a single domain could achieve alone. This upgraded value is systemic, addressing not just individual problems but broader cross-domain or industry-wide challenges. In cybersecurity, migrated reinforcement learning capabilities and reconstructed multi-stakeholder scenarios combine to deliver a value upgrade: "risk-cost balance" [4][5]. Zhou's [4] M-VP2 method and hybrid SAST-DAST-SCA-IAST framework [5] do not just prioritize vulnerabilities (single-domain value) but balance risk reduction, operational continuity, and cost control—delivering systemic value that aligns technical security with business objectives. In digital commerce, migrated federated learning capabilities and reconstructed compliant collaboration scenarios create the value upgrade of "inclusive, privacy-respecting innovation" [3][7][8]. Yi's frameworks do not just enable cross-channel marketing (single-domain value) but ensure that SMEs can participate alongside large corporations, and users' privacy is protected while creators monetize—delivering systemic value that balances business growth, user rights, and inclusive access. In healthcare, migrated computer vision capabilities and reconstructed clinical scenarios result in the value upgrade of "early, accurate diagnosis at scale" [1]. PDU-Net's precise segmentation does not just improve individual lesion detection (single-domain value) but enables early lung cancer intervention, reducing healthcare system burdens and improving population health—delivering systemic value that transcends individual clinical encounters. In finance, migrated LSTM capabilities and reconstructed portfolio optimization scenarios create the value upgrade of "robust, data-driven investment efficiency" [9], while AI-driven ESG tools (built on migrated optimization capabilities) deliver the upgrade of "sustainable finance for all" [6]—enabling SMEs to improve ESG ratings with limited resources, transcending the traditional value of ESG as a large-corporation privilege. Value upgrade thus transforms AI from a domain-specific tool to a systemic value driver, unlocking cross-domain impact that no single domain could achieve in isolation.

3 Evolutionary Path Application Across Domains

3.1 Healthcare: Capability Migration (Computer Vision → 3D Medical Imaging) → Scenario Reconstruction (General Segmentation → Clinical Lung Nodule Diagnosis) → Value Upgrade (Lesion Detection → Early Cancer Intervention at Scale)

The evolutionary path here is clear: computer vision's segmentation capability migrates to 3D medical image processing [1], is reconstructed to fit radiologists' clinical workflow [1], and upgrades value from individual lesion detection to population-level early lung cancer intervention. This path demonstrates how technical migration and scenario reconstruction combine to create healthcare system-wide impact.

3.2 Quantum Science: Capability Migration (Unsupervised Learning → Quantum Data Analysis) → Scenario Reconstruction (General Unlabeled Data → Quantum System Modeling) → Value Upgrade (Pattern Extraction → Accelerated Quantum Material Discovery)

Wu et al.'s [2] research follows this path: unsupervised learning's pattern extraction capability migrates to high-dimensional quantum data [2], is reconstructed to fit quantum system simulation scenarios [2], and upgrades value from basic data analysis to accelerating quantum material research—delivering value that transcends individual quantum system modeling.

3.3 Digital Commerce: Capability Migration (Federated Learning → Cross-Channel Data Collaboration) → Scenario Reconstruction (General Data Sharing → Compliant SME-Friendly Collaboration) → Value Upgrade (Data Collaboration → Inclusive, Privacy-Respecting Business Growth)

Yi's [3][7][8] frameworks exemplify this evolutionary path: federated learning's privacy-preserving capability migrates to digital commerce data sharing [3][8], is reconstructed to fit cross-channel marketing and SME resource constraints [7], and upgrades value from simple collaboration to inclusive growth that balances business needs, user privacy, and SME accessibility.

3.4 Cybersecurity: Capability Migration (Reinforcement Learning → Vulnerability Management) → Scenario Reconstruction (Single-Agent Decision → Multi-Stakeholder Patch Planning) → Value Upgrade (Vulnerability Prioritization → Risk-Cost-Business Balance)

Zhou's [4][5] solutions follow this path: reinforcement learning's decision-making capability migrates to vulnerability management [4], is reconstructed to fit multi-stakeholder collaboration scenarios [5], and upgrades value from technical vulnerability prioritization to systemic risk-cost-business balance—delivering value that aligns cybersecurity with organizational objectives.

3.5 Finance: Capability Migration (LSTM/Optimization → Financial Forecasting/ESG) → Scenario Reconstruction (General Sequence/Optimization → Portfolio/SME ESG) →

Value Upgrade (Prediction/Optimization → Robust Investment/Sustainable Finance Inclusion)

Finance's evolutionary path has two branches: LSTM's sequential capability migrates to financial forecasting [9], is reconstructed to fit portfolio optimization scenarios [9], and upgrades value to robust investment efficiency; optimization algorithms migrate to ESG improvement [6], are reconstructed to fit SME resource constraints [6], and upgrade value to inclusive sustainable finance—both branches delivering systemic value beyond single-domain applications.

4 Practical Implications of the Evolutionary Path

4.1 For Researchers

Design AI with evolvability in mind: develop modular technical cores that facilitate migration across domains [1][9], anticipate scenario reconstruction needs during technical design [3][4], and target value upgrade rather than just single-domain performance [6][8]. For example, when building computer vision models, design adaptable feature extraction modules that can migrate to medical imaging [1]; when developing federated learning, consider scenario reconstruction for diverse stakeholders (e.g., SMEs) [7].

4.2 For Practitioners

Adopt a phased approach to cross-domain AI adoption: first, identify relevant technical capabilities to migrate (e.g., LSTM for finance [9], federated learning for digital commerce [3]); second, reconstruct scenarios to fit real-world needs (e.g., multi-stakeholder collaboration in cybersecurity [4]); third, measure value upgrade beyond immediate outcomes (e.g., SME inclusion in digital commerce [7], population health in healthcare [1]). Avoid stopping at capability migration—scenario reconstruction and value upgrade are critical for transformative impact.

4.3 For Policymakers

Support the full evolutionary path with targeted policies: fund research on modular, migratable AI technologies [2][9]; create regulatory frameworks that enable scenario reconstruction (e.g., flexible privacy laws for digital commerce [3][8]); and incentivize value upgrade (e.g., grants for AI tools that promote SME ESG inclusion [6], population health [1]). Policies should not just encourage cross-domain AI but guide it toward systemic value.

5 Future Directions and Conclusion

Future research should focus on: first, mapping evolutionary path dynamics (e.g., how long each stage takes, what triggers progression from migration to reconstruction); second, developing tools to accelerate the path (e.g., modular AI libraries for migration, scenario design platforms for reconstruction); third, exploring cross-path synergies (e.g., how healthcare's evolutionary path can inform quantum science's). Additionally, research on

evolutionary failures (e.g., technical migration without scenario reconstruction) could provide insights into common barriers.

This review synthesizes 9 recent studies to propose the "capability migration-scenario reconstruction-value upgrade" evolutionary path for cross-domain AI innovation. The framework reveals that AI's cross-domain impact is a dynamic process—starting with technical adaptation, progressing through scenario alignment, and culminating in systemic value that transcends single domains. By understanding this evolutionary path, researchers, practitioners, and policymakers can guide AI's cross-domain expansion toward transformative, inclusive, and sustainable impact—unlocking AI's full potential as a cross-sector value driver.

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