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Mapping Cognitive Convergence: A Network Perspective on Institutional Influence and Sectoral Trajectories in Quantum-AI Research for Cybersecurity Innovation

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The rapid convergence of quantum computing and artificial intelligence (AI) signals a foundational shift in the development of next-generation digital systems. Beyond technical advancement, this convergence holds critical implications for cybersecurity, particularly in quantum cryptography, post-quantum security, and algorithmic risk mitigation. Although academic output in this domain has grown rapidly, there remains limited understanding of how institutional actors are structuring this convergence and how their research aligns with sector-specific priorities, especially in cybersecurity.

This study applies Social Network Analysis methodologies to examine institutional relationships and knowledge diffusion patterns within the quantum-AI research landscape. A systematic review is conducted using the PRISMA framework on identified literature from reputed journals and conference proceedings. Employing network visualisation and transformer-based natural language processing models, the study constructs semantic co-occurrence and institutional affiliation networks to trace conceptual evolution and collaborative network structures. Key research themes such as variational circuits, quantum kernels, explainability, and optimisation are extracted and analysed to identify domains of cognitive convergence.

Institutional affiliation analysis classifies academic, governmental, and corporate contributors. Co-authorship patterns and topic relevance are examined to assess alignment with cybersecurity-related sectors. The resulting network structures highlight patterns of concentration, collaboration gaps, and emerging translational actors shaping the interface between research and applied cybersecurity innovation.

By revealing the institutional architecture and sectoral trajectories of quantum-AI research, this study contributes a network-informed framework for understanding how interdisciplinary innovation diffuses from research environments into security-focused solutions for practical domains. These insights support policy design, research funding strategies, and long-term planning in broader contexts of digital transformation and technological governance.

Keywords/Topics

Quantum Computing, Artificial Intelligence, Social Network Analysis, Cybersecurity Innovation, Knowledge Diffusion, Institutional Collaboration, Digital Transformation

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