Shaping Tomorrow: The Convergence of Artificial General Intelligence and Quantum Computing

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Abstract

Artificial General Intelligence (AGI) and quantum computing together constitute a revolutionary technological frontier that has the potential to completely reshape human innovation and problem-solving. AGI, with its potential to mimic and surpass human cognitive abilities, offers unprecedented opportunities for creativity, adaptability, and autonomy in artificial systems. Utilizing the concepts of superposition and entanglement, and quantum computing, promises exponential computational power, making it a catalyst for accelerating AGI development and addressing complex global challenges. This chapter explores the dynamic interplay between these revolutionary technologies, delving into their theoretical foundations, current advancements, and future trajectories. It examines the potential of quantum-enhanced algorithms to overcome AGI's computational limitations, enabling innovations in fields like medication discovery, climate modelling, and secure data systems. Additionally, it addresses the ethical, societal, and security challenges inherent in these innovations, emphasizing the need for human-centric and globally inclusive frameworks. As AGI and quantum computing mature, their integration will redefine industries, economies, and the very fabric of human existence. This chapter outlines a roadmap for harnessing their combined potential responsibly, ensuring a future where technological progress aligns with humanity's broader aspirations.

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Keywords

Artificial General Intelligence (AGI) · Quantum computing · Machine learning · Human-centric AI · AI-quantum synergy · Global governance

1 Introduction

The technological landscape of the twenty-first century has been shaped by two groundbreaking advancements: Artificial Intelligence (AI) and quantum computing. While narrow AI systems have already revolutionized sectors as logistics, health care, and finance, the idea of Artificial General Intelligence (AGI) promises an even more profound shift. AGI describes machines that can carry out every intellectual work that a person can, demonstrating reasoning, problem-solving, and adaptability that rival or surpass human intelligence. Achieving AGI is widely regarded as an upcoming significant event in the development of intelligent systems. Simultaneously, quantum computing is emerging as a paradigm-shifting technology, leveraging quantum mechanical concepts to address issues that traditional computers are unable to handle. By processing enormous volumes of data in parallel using phenomena like superposition, entanglement, and tunnelling, quantum systems have made significant strides in material science, optimization, and cryptography. AGI and quantum computing's convergence is more than just a speculative possibility but an imminent reality with transformative potential. Quantum computing offers the computational horsepower to address the resource-intensive demands of AGI development, while AGI systems could enhance quantum research by optimizing algorithms and accelerating problem-solving. Together, these technologies are poised to reshape industries, economies, and societal structures. AGI and quantum computing's entwined futures are examined in this chapter. It delves into their theoretical underpinnings,

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current advancements, and the synergies that could catalyse unprecedented technological progress. Moreover, it examines the ethical, societal, and security implications of these developments, emphasizing the importance of aligning technological innovation with humanity's broader values and goals. As we approach the dawn of this technological revolution, realizing the possibilities of AGI and quantum computing—and preparing for their impact—is crucial. This chapter seeks to illuminate the paths forward, offering insights into the problems and opportunities that this extraordinary confluence of innovation presents (Russell and Norvig 2021; Tegmark 2017; Bostrom 2014).

Key Contributions of the Chapter

- Highlights the foundational principles of quantum computing and Artificial General Intelligence (AGI), elucidating their individual and collective capabilities;
- Explores the complementary nature of AGI and quantum computing, focusing on how their integration could accelerate advancements in machine learning, optimization, and problem-solving;
- Analyses societal and ethical implications, addressing challenges such as AI alignment, data privacy, and the risks associated with emerging quantum technologies;
- Provides a future roadmap, discussing technological milestones, interdisciplinary collaboration, and the policies required for responsible development and deployment.

The chapter is organized as follows: After introducing the topic and its significance, Sect. 2 delves into the fundamentals of AGI, while Sect. 3 provides an overview of quantum computing. Section 4 discusses their synergies and potential applications. Section 5 addresses societal and ethical concerns, followed by Sect. 6, which outlines a future roadmap for integrating AGI and quantum computing. The conclusion synthesizes the insights and emphasizes the need for balanced progress.

2 Understanding Artificial General Intelligence (AGI)

The aspirational objective of developing robots that are capable of carrying out every intellectual job that a human being can is known as artificial general intelligence, or AGI. AGI aims to mimic the depth and breadth of human intellect, in contrast to narrow AI, which is best at specialized tasks like image recognition, natural language processing, or playing challenging games. Many individuals view the creation of AGI as the "holy grail" of artificial intelligence research, promising a future where machines not only complement

Table 1 AGI system design

Generalized learning abilities	The capacity to learn from diverse experiences and apply knowledge across unrelated domains
Autonomous problem-solving	The ability to independently define problems and devise solutions without external guidance
Contextual awareness	Understanding nuanced contexts and adapting behaviours accordingly, much like human intelligence
Continuous self-improvement	The potential to refine its own algorithms and improve its performance over time

Fig. 1 Artificial General Intelligence (AGI)

human efforts but also innovate independently. AGI differs fundamentally from narrow AI in its scope and adaptability (Bengio et al. 2021; Goertzel 2007). Narrow AI systems are designed for specialized applications, with capabilities confined to predefined parameters. Artificial Quantum Intelligence (AGI), on the other hand, is depicted in Table 1 and Fig. 1.

In essence, AGI would function as a versatile, self-sustaining intelligence capable of performing complex reasoning, abstraction, and creativity at or beyond human levels. While no system currently meets the criteria for AGI, significant strides have been made toward its development. Advances in deep learning, reinforcement learning, and neural network architectures have laid the groundwork for more sophisticated AI systems. Prominent research entities,

Table 2 The key milestones in AGI research

Large Language Models (LLMs)	Systems like GPT-4 have demonstrated remarkable abilities in generating human-like text, reasoning, and problem-solving within certain boundaries
AlphaZero and beyond	Programs such as AlphaZero have shown adaptability by mastering multiple games with minimal human intervention, hinting at the potential for generalized learning
Neuroscience-inspired models	Research in brain-like architectures seeks to replicate the human brain's structure and functionality in machine form

Table 3 Key challenges in AGI development

Technical challenges	Computation	Current hardware and software are inadequate for the vast computational demands of AGI
	Learning paradigms	Developing algorithms that enable machines to learn as flexibly and efficiently as humans remains an unresolved problem
	Reasoning and abstraction	Existing AI systems struggle with complex reasoning and abstract thought, which are critical for AGI
Ethical and societal concerns	Bias and fairness	Ensuring AGI operates without perpetuating societal biases is a critical challenge
	Control and safety	Aligning AGI with human values and preventing unintended consequences require robust control mechanisms
	Economic disruption	The widespread adoption of AGI could lead to significant shifts in labour markets and exacerbate inequalities
Existential risks	The emergence of AGI raises questions about its potential autonomy and decision-making authority. Ensuring that AGI serves humanity rather than becoming a threat necessitates proactive oversight and governance	

including OpenAI, DeepMind, and various academic institutions, are leading efforts to bridge the gap between narrow AI and AGI. Table 2 depicts the key milestones in AGI research. Despite these achievements, AGI remains an ambitious goal, requiring breakthroughs in scalability, algorithmic efficiency, and cognitive modelling. Table 3 illustrates that the journey to AGI is fraught with technical, ethical, and societal challenges. The successful development of AGI could revolutionize every aspect of human life. From solving complex scientific problems to transforming industries and addressing worldwide issues like climate change and pandemics, AGI possesses the potential for unprecedented progress. However, realizing this potential depends on navigating its development responsibly and inclusively. In the context of its intersection with quantum computing, AGI represents a key beneficiary of quantum advancements. The synergy between these technologies could accelerate AGI research, bringing us closer to this ambitious vision. This relationship is explored further in subsequent sections of the chapter (Russell and Norvig 2021; Ertel 2018; Silver et al. 2017).

3 Overview of Quantum Computing

A revolutionary area of technology, quantum computing uses the ideas of quantum physics to process data in ways that are essentially distinct from those of traditional computers (Arute et al. 2019). By exploiting concepts like superposition, entanglement, and quantum interference, quantum computers could potentially resolve issues that are currently intractable, offering revolutionary applications across a range of industries (Deutsch 1985; Gisin et al. 2002; Nielsen and Chuang 2010). Table 4 briefs the Principles of Quantum Computing, while Table 5 depicts the Crucial Elements of Quantum Computers. These ideas serve as the foundation for quantum computing's special benefits over classical systems, particularly in areas requiring parallelism and probabilistic

Table 4 Principles of quantum computing

Superposition	Bits, which can be either 0 or 1, are the fundamental units of information in classical computing. Quantum bits, also known as qubits, are capable of simultaneously representing 0 and 1 in a superposition of states. This characteristic significantly boosts the computing power of quantum computers (Fig. 2) for specific workloads by enabling them to do numerous calculations simultaneously
Entanglement	Quantum phenomena known as entanglement occur when qubits become correlated to the point that, independent of their distance from one another, the states of the two qubits are directly connected. This enables highly efficient information sharing and coordination between qubits, which is critical for quantum computing's unique capabilities
Quantum interference	In order to make computations more efficient, quantum algorithms use interference to increase the likelihood of accurate answers while eliminating wrong ones

Fig. 2 A quantum computer

Table 5 Key components of quantum computers

Qubits	Physical realizations of qubits include superconducting circuits, trapped ions, photons, and quantum dots. Each qubit must be maintained in a delicate quantum state, requiring highly controlled environments to minimize decoherence
Quantum gates	Qubits are manipulated by quantum gates using operations that take advantage of quantum phenomena. Similar to logic gates in traditional computers, these gates are the fundamental components of quantum circuits
Quantum hardware and platforms	Quantum computers rely on specialized hardware capable of isolating and controlling qubits. Current systems are in the noisy intermediate-scale quantum (NISQ) phase, when there are error-prone, small-scale quantum computers

Table 6 Significant challenges of QC

Decoherence	Maintaining quantum states long enough to complete useful computations
Error correction	Developing reliable methods to identify and fix mistakes without interfering with quantum data
Scalability	Building systems with a sufficient number of stable qubits to tackle real-world problems

Table 7 Quantum algorithms and applications

Key algorithms	Shor's algorithm	Threatens existing encryption methods by effectively factoring big numbers
	Grover's algorithm	Speeds up unstructured search problems, doubling the efficiency compared to classical methods
	Variational Quantum Eigensolver (VQE)	Used for molecular simulation optimization, which has applications in materials research and medicinal development
Emerging applications span industries	Cryptography	Developing quantum-safe encryption methods to counteract the risks posed by Shor's algorithm
	Optimization	Solving complex logistical and resource allocation problems
	Healthcare	Accelerating drug discovery and personalized medicine
	Climate science	Modelling intricate systems to better understand and mitigate climate change

problem-solving. While the technology (Reddy et al. 2024) has demonstrated promise, significant challenges remain, as illustrated in Table 6. Quantum computing excels in solving some issues that are exponentially faster than traditional systems, as depicted in Table 7. The roadmap for quantum computing includes advancing hardware stability, scaling systems, and integrating quantum solutions with classical computing infrastructure (Vazirani and Vidick 2019; Cao et al. 2019; Childs and Van Dam 2010). As quantum computing develops, its effects are anticipated to spread to domains including materials science, cryptography, and artificial intelligence (Devitt et al. 2013; Lloyd 1996). The application of quantum computing to Artificial General Intelligence (AGI) provides an additional pathway for overcoming computational bottlenecks and enabling the rapid development of sophisticated AI systems. This synergy is explored in detail in subsequent sections (Shor 1997; Zurek 2003).

4 Synergies Between AGI and Quantum Computing

The combination of quantum computing and artificial general intelligence (AGI) is a revolutionary synergy with the potential to revolutionize science, technology, and human progress. While AGI seeks to emulate or surpass human cognitive capabilities, quantum computing offers unparalleled computational power for solving complex problems (Biamonte et al. 2017; Harrow et al. 2009). Together, these technologies (Singh et al. 2024) can accelerate advancements, pushing the boundaries of what is computationally and intellectually possible, as shown in Table 8. Table 9 shows how quantum computing introduces novel algorithms that can directly enhance AGI functionality. Table 10 illustrates how

Table 8 How quantum computing can accelerate AGI

Enhanced machine learning algorithms	**Quantum Speedup**: Quantum computing enables faster processing of data-intensive tasks such as training neural networks, reducing computational time from years to hours in certain scenarios
	Quantum Kernels for Machine Learning: Quantum computers are better at processing high-dimensional data, improving pattern recognition and predictive accuracy in AGI systems
Optimization problems	Many AGI tasks, such as learning algorithms and making decisions, entail resolving optimization issues. Using methods such as the Quantum Approximate Optimization Algorithm (QAOA), quantum computing can offer effective answers, significantly improving AGI's ability to handle complex scenarios
Boosting data security	AGI systems rely heavily on secure data transmission and storage. Quantum computing facilitates the development of quantum cryptography, safeguarding AGI systems against hacking and data breaches
Accelerating cognitive simulations	Simulating neural networks and cognitive architectures for AGI requires substantial computational resources. Quantum simulations can model these systems with greater precision and efficiency, advancing AGI research

Table 9 Quantum algorithms for AGI applications

Grover's algorithm	Increases the efficiency of search and retrieval operations within AGI systems, aiding in tasks like database querying and semantic search
Quantum Neural Networks (QNNs)	QNNs, a combination of neural networks and quantum computing, are capable of processing and analysing large, complicated datasets, enhancing AGI's ability to generalize and learn from diverse sources
Variational quantum algorithms	Used for optimization tasks and training AGI models, offering solutions to problems too complex for classical systems
Boltzmann machines	Advanced quantum Boltzmann machines are promising tools for probabilistic reasoning and unsupervised learning in AGI, improving its ability to understand uncertain or incomplete data

the integration of AGI and quantum computing can catalyse breakthroughs across industries. Managing the behaviour of AGI systems accelerated by quantum power requires robust frameworks to prevent unintended consequences, as described in Table 11. The relationship between AGI and quantum computing is still in its early stages, it has enormous potential. Table 12 depicts the Future milestones in their synergy. The interplay between AGI and quantum computing is poised to redefine humanity's approach to innovation, enabling breakthroughs that were once relegated to the realm of science

Table 10 Potential breakthroughs and applications

Health care and drug discovery	Quantum-powered AGI can precisely design medications and mimic molecular interactions, cutting down on development costs and timeframes
Climate modelling and sustainability	AGI, supported by quantum computing, can analyse complex climate models to predict and mitigate environmental challenges, optimize energy usage, and design sustainable solutions
Advanced robotics and automation	Quantum-enhanced AGI can drive more adaptive and intelligent robotics, enabling advancements in autonomous systems for industries like manufacturing, agriculture, and space exploration
Economic and financial modelling	Quantum AGI systems can revolutionize economic forecasting, risk analysis, and market predictions, providing unprecedented insights for decision-makers
Fundamental science and exploration	From decoding the mysteries of the universe to advancing fundamental physics, quantum AGI can tackle problems that currently elude human understanding

Table 11 Challenges in combining AGI and quantum computing

Computational complexity	Quantum computers are not universally faster; identifying tasks where quantum speedup applies requires careful optimization and problem matching
Integration issues	Combining AGI architectures with quantum systems demands specialized hardware, algorithms, and infrastructure that are still in developmental stages
Ethical concerns	The dual use of these technologies raises risks, such as their potential misuse in surveillance, weaponization, or exacerbating inequalities
Control and safety	Managing the behaviour of AGI systems accelerated by quantum power requires robust frameworks to prevent unintended consequences

Table 12 Future prospects of AGI and quantum computing synergy

Hybrid architectures	Developing systems that integrate classical, quantum, and AGI components for optimal performance
Scalable quantum systems	Expanding the capacity of quantum hardware to support large-scale AGI applications
Global collaboration	Advancing research through partnerships between governments, business, and academia to maximize the potential of these technologies responsibly
AI-optimized quantum development	Using AGI to design and optimize quantum algorithms, accelerating progress in both fields simultaneously

fiction. By fostering collaboration and addressing the challenges inherent in this synergy, society can unlock unprecedented opportunities to advance science, technology, and human welfare (Montanaro 2016; Preskill 2018; Verdon et al. 2019).

5 Societal and Ethical Implications

The convergence of Artificial General Intelligence (AGI) and quantum computing brings extraordinary promise but also profound challenges. These technologies have the potential to redefine societal norms, economic structures, and even our understanding of ethics (Brynjolfsson and McAfee 2014; Floridi 2013; McKinsey Global Institute 2022). While the benefits are vast, from tackling global challenges to accelerating innovation, the risks-ranging from economic disruption to existential threats-demand careful scrutiny and proactive management as depicted in Table 13. In order to minimize hazards and maximize the advantages of AGI and quantum computing, a proactive approach is necessary, as illustrated in Table 14. The societal and ethical implications of AGI and quantum computing are as profound as the technologies themselves (Tegmark 2017; Yudkowsky 2008; Amodei et al. 2016). Balancing innovation with responsibility will determine whether their impact is a boon or a burden for humanity. By embedding ethics, fostering inclusivity, and promoting global collaboration (Sreelatha et al. 2024), we can create a path for the future where these technologies amplify human potential without compromising societal values (Bostrom 2014; Cowen and Southwood 2020).

6 Future Roadmap for AGI and Quantum Computing

The journey toward fully realized Artificial General Intelligence (AGI) and scalable quantum computing is a multifaceted challenge that requires breakthroughs in technology, governance, ethics, and interdisciplinary collaboration. This roadmap outlines the key milestones, strategies, and priorities for achieving these goals responsibly while maximizing their transformative potential for humanity (Bostrom 2014; Cowen and Southwood 2020; Schatsky and Piscini 2019). The future of AGI and quantum computing is a defining narrative of the twenty-first century, with the potential to reshape human civilization. By prioritizing responsible development, fostering global collaboration, and addressing ethical and societal challenges, humanity can ensure these technologies serve as catalysts for progress, equity, and sustainability. The roadmap ahead, as depicted in Table 15, is complex but holds the promise of unparalleled innovation and opportunity.

7 Conclusion

The convergence of quantum computing and artificial general intelligence (AGI) is one of the twenty-first century's most revolutionary technological developments. These technologies hold the potential to redefine human capabilities, enabling breakthroughs across healthcare, climate science, advanced robotics, cryptography, and countless other domains. However, their integration is not without profound challenges, necessitating a deliberate, ethical, and inclusive approach to development and deployment. Quantum computing enhances AGI's computational capabilities, allowing for faster problem-solving, improved optimization, and deeper insights into complex systems. Similarly, AGI's ability to learn, adapt, and design can accelerate the development of quantum algorithms and systems, creating a synergistic feedback loop that drives innovation. Together, they promise to address global challenges, advance scientific knowledge, and unlock new frontiers in technology. Yet, this potential must be balanced against significant societal, ethical, and existential risks. The weaponization of these technologies, the erosion of privacy, economic disruption, and the potential for unaligned AGI systems are critical issues that require proactive governance and global cooperation. The creation of ethical frameworks, equitable access strategies, and robust regulatory systems will be key to ensuring these technologies are used for the good of humanity as a whole. As we move forward, the roadmap for AGI and quantum computing must emphasize collaboration, accountability, and resilience. Interdisciplinary efforts combining technical expertise, ethical considerations, and societal engagement will be essential to navigating this rapidly evolving landscape. The ultimate goal should not only be technological advancement but also the enhancement of human well-being and the safeguarding of our shared future. By embracing both the possibilities and difficulties presented by AGI and quantum computing, humans can influence a future defined by innovation, equity, and progress—one where these powerful tools serve as catalysts for solving the most pressing issues of our time and unlocking the full potential of human civilization.

Table 13 Societal and ethical implications

Transforming economies and industries	Economic growth and new opportunities	AGI-quantum integration could supercharge sectors like energy, healthcare, banking, and logistics. Quantum-enhanced AGI can optimize supply chains, revolutionize manufacturing with advanced robotics, and unlock breakthroughs in materials science and drug development
	Labor market disruption	AGI-driven automation may result in widespread employment losses, particularly in industries that depend on repetitive or analytical work. Quantum computing may exacerbate this by accelerating AGI's capabilities, outpacing the workforce's ability to adapt. A shift toward upskilling and reskilling becomes essential, emphasizing creativity, emotional intelligence, and advanced problem-solving
	Global inequality	Countries and corporations with access to AGI and quantum computing may gain disproportionate power, widening the difference in technology between "haves" and "have-nots." It is essential to guarantee that these technologies are accessible to all to prevent further global disparities
Ethical dilemmas	Data privacy and security	Quantum computing poses a threat to existing encryption systems, endangering personal and organizational data. AGI systems, especially those with quantum-enhanced data analysis capabilities, could amplify surveillance and privacy violations. Quantum cryptography offers a potential solution, but its widespread implementation is years away
	Bias and fairness	AGI systems trained on biased data sets could perpetuate or even amplify societal prejudices. Quantum computing's role in accelerating AGI training underscores the need for transparent, fair, and inclusive data practices
	Autonomy and accountability	As AGI systems become more autonomous, determining responsibility for their actions becomes a critical ethical challenge. Quantum-enhanced AGI could introduce unintended consequences faster than humans can intervene, raising concerns about control and oversight
Security and existential risks	Weaponization	The combination of AGI and quantum computing could enable highly advanced autonomous weapons, cyberattacks, and espionage tools. Quantum-secured communication could protect against some threats but might also empower authoritarian regimes to suppress dissent
	Unaligned AGI	AGI systems may develop goals misaligned with human values, posing existential risks if left unchecked. Quantum computing's speed and power could exacerbate the challenge of ensuring AGI alignment, as systems evolve rapidly beyond human control
	Runaway scenarios	The rapid, recursive improvement of AGI facilitated by quantum computing might lead to intelligence far surpassing human understanding. Establishing fail-safes and control mechanisms to prevent runaway scenarios is paramount
Human-centric and inclusive frameworks	Global governance	The development of international regulations and agreements is essential to managing AGI and quantum computing responsibly. Collaborative frameworks can address risks like cybersecurity, ethical breaches, and inequitable access to technology
	Ethics by design	Embedding ethical principles into AGI systems from inception ensures accountability, transparency, and fairness. Quantum computing's role in processing large-scale data offers an opportunity to enforce real-time ethical checks within AGI systems
	Educational reform	Preparing societies for the AGI-quantum era requires revamping education systems to emphasize interdisciplinary skills. Cultivating a generation proficient in both these technologies' technical and moral aspects will be critical
Social impacts of technological dependency	Erosion of human skills	Over-reliance on AGI systems may lead to a decline in critical thinking, creativity, and problem-solving skills. Quantum-enhanced automation risks creating a "black box" society where technology's inner workings are opaque to most people
	Mental health and identity	AGI systems capable of human-like interactions could blur the lines between human and machine, raising questions about relationships, identity, and emotional health. The societal impact of AGI's integration into daily life-combined with the rapid pace of quantum-driven change-may lead to widespread anxiety or resistance

Table 14 The need for proactive management

Regulation and oversight	Governments must establish regulations to ensure ethical development and prevent misuse
Public awareness	Society must be educated about the implications of these technologies, empowering individuals to adapt and contribute to the discourse
Collaborative innovation	Public and private sectors must collaborate to address technical and ethical challenges, ensuring these technologies serve the collective good

Table 15 Future roadmap for AGI and quantum computing

Advancing technological foundations	AGI development	**Scalable Architectures**: Develop modular AI frameworks capable of integrating learning from diverse domains **Neuroscience-Inspired Models**: Enhance cognitive simulations by mimicking neural and synaptic processes to emulate human-like reasoning **Self-improving Systems**: Create AGI systems that can autonomously refine their algorithms without losing alignment with human goals
	Quantum computing development	**Error Correction**: Invest in cutting-edge quantum error correcting methods to lessen the effects of noise and decoherence **Increased Qubit Stability**: Achieve breakthroughs in stabilizing and controlling qubits, enabling longer and more reliable computation cycles **Scalable Quantum Systems**: Transition to fault-tolerant, large-scale quantum computing systems from the current NISQ (Noisy Intermediate-Scale Quantum) era
Enhancing synergies between AGI and quantum computing	Hybrid systems	Combine classical, quantum, and AGI systems into hybrid architectures that exploit the strengths of each technology
	Quantum algorithms for AGI	Develop specialized quantum algorithms that accelerate AGI capabilities, such as quantum neural networks and optimization models
	AI-assisted quantum development	Leverage advanced AI to optimize quantum algorithms, simulate quantum systems, and design hardware configurations
Ethical and regulatory frameworks	Global governance	Establish international treaties and organizations to regulate the development and use of AGI and quantum computing, ensuring ethical practices and equitable access
		Define clear guidelines for dual-use technologies to prevent misuse in areas such as weaponization or surveillance
	Ethical AI design	Embed ethics into AGI systems using frameworks that prioritize transparency, accountability, and alignment with human values
		Develop tools to audit and monitor AGI systems in real-time, ensuring compliance with ethical standards
	Quantum-safe encryption	Implement quantum-resistant cryptographic protocols to secure sensitive information against potential quantum threats
Addressing societal impacts	Workforce adaptation	Create programs for upskilling and reskilling the workforce to adapt to jobs enabled by AGI and quantum computing
		Promote interdisciplinary education that combines technical, ethical, and societal perspectives
	Equitable access	Ensure that advancements in AGI and quantum computing benefit all segments of society, avoiding disproportionate gains for certain regions or entities
		Fund open-access research initiatives to democratize these technologies
	Public engagement	Foster a societal dialogue about the implications of AGI and quantum computing, emphasizing transparency and inclusivity in decision-making
Key milestones for the next decades	Short-term (0–5 yrs)	Expand NISQ applications in industries such as logistics, healthcare, and finance
		Develop preliminary quantum-assisted AI systems for specialized tasks
		Launch pilot programs for ethical AGI development and public awareness campaigns
	Mid-term (5–15 yrs)	Achieve scalable, quantum computers that are resilient to errors and can resolve significant issues
		Demonstrate AGI systems with generalized problem-solving abilities while ensuring alignment with human values
		Establish robust global regulatory frameworks and ethical guidelines for both technologies
	Long-term (15+ yrs)	Fully integrate AGI and quantum computing into hybrid systems, enabling superintelligent capabilities
		Address existential risks by embedding strong safety mechanisms into advanced AGI systems

(continued)

Table 15 (continued)

		Utilize AGI-quantum systems to tackle grand challenges such as climate change, pandemics, and space exploration
Interdisciplinary collaboration	Academic research	Promote interdisciplinary studies combining AI, quantum physics, ethics, and social sciences
		Foster partnerships between universities and technology companies to accelerate research
	Public–Private partnerships	Encourage collaborations between governments, private companies, and NGOs to share knowledge, funding, and infrastructure
	Open innovation ecosystem	Encourage open-source projects to make sure that the advantages of artificial general intelligence (AGI) and quantum computing are shared broadly and developed cooperatively
Preparing for the unknown	Scenario planning	Develop models to predict and prepare for various scenarios, including disruptive breakthroughs, societal resistance, or ethical dilemmas
	Resilience strategies	Build robust systems that can adapt to unexpected challenges, such as rapid advancements or misuse of these technologies
	Future-proof governance	Create adaptive regulatory systems capable of evolving alongside technological advancements to remain relevant and effective

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