Rethinking Intelligence: An Interdisciplinary Framework for AI Research

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Abstract

The pursuit of artificial intelligence (AI) has historically been fragmented across multiple domains such as computer science, cognitive psychology, neuroscience, philosophy, and linguistics, each contributing distinct perspectives and methodologies. However, as AI systems grow increasingly complex and integrated into the fabric of modern society, the need for a comprehensive and unified framework for understanding and advancing intelligence has become critical. This paper proposes an interdisciplinary approach to AI research that draws from both the empirical and conceptual contributions of various scientific and humanistic disciplines. By rethinking intelligence not merely as computation but as an emergent phenomenon influenced by context, embodiment, learning, and social interaction, we can foster a more nuanced and robust path for AI development. The discussion centers on integrating theoretical models with empirical data, emphasizing the necessity for ethical design, cognitive plausibility, and long-term alignment with human values. This framework is designed to support a more cohesive, resilient, and inclusive trajectory for future AI systems.

Keywords: Artificial intelligence, interdisciplinary research, cognitive science, embodied cognition, computational models, ethics in AI, intelligence theory, systems thinking, human-AI alignment

Introduction

Intelligence, as a concept, has long fascinated scientists, philosophers, and engineers[1]. From the early philosophical debates about the mind and reason to the modern-day engineering of intelligent machines, the quest to understand and replicate intelligence has evolved dramatically.

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Artificial intelligence, in particular, has achieved significant milestones in recent decades, including game-playing superintelligence, conversational agents, autonomous vehicles, and advanced language models[2]. Despite these technical accomplishments, fundamental questions about the nature of intelligence remain unanswered. Is intelligence purely computational, or is it deeply embedded in biology, context, and physical embodiment? Can machines truly understand or merely simulate understanding? These inquiries underscore the limitations of viewing intelligence solely through the lens of narrow computationalism and call for a broader, more integrative research approach[3].

The field of AI has traditionally been driven by computer science and engineering, emphasizing algorithmic efficiency, data-driven learning, and task performance. However, this technological orientation often neglects the rich insights offered by cognitive science, neuroscience, linguistics, anthropology, and even philosophy. Cognitive science, for example, investigates how humans perceive, reason, learn, and act, offering models that could inform more human-like AI systems[4]. Neuroscience provides biological underpinnings that could inspire new architectures or learning mechanisms, such as spiking neural networks and memory consolidation. Philosophy contributes conceptual clarity regarding consciousness, intentionality, and ethical responsibility, which are increasingly relevant as AI systems make decisions that affect human lives[5].

In light of these disciplinary insights, this paper argues for rethinking intelligence as a multi-faceted, emergent capability that cannot be fully captured by a single scientific domain. The complexity of real-world intelligence necessitates a systems-level understanding that integrates multiple dimensions—computation, embodiment, social interaction, language, and value alignment. Such an interdisciplinary framework not only broadens the scope of inquiry but also enriches the design principles and evaluation metrics for AI systems[6].

Furthermore, as AI systems are deployed in environments ranging from healthcare and education to finance and law enforcement, their impacts extend beyond technical functionality to social, ethical, and philosophical domains[7]. This reality reinforces the importance of including ethical frameworks and value-sensitive design in AI research. Questions surrounding bias, transparency, autonomy, and accountability must be addressed through collaborative efforts among ethicists, sociologists, legal scholars, and technologists[8].

The emerging discipline of artificial general intelligence (AGI) particularly benefits from this holistic view. While current AI systems excel in narrow tasks, AGI aspires to replicate the flexible, adaptive, and general-purpose intelligence characteristic of humans[9]. Achieving this goal demands not only engineering ingenuity but also a deeper understanding of the principles that govern natural intelligence. In this context, interdisciplinary collaboration becomes not just beneficial but essential[10].

By reframing intelligence as a deeply interconnected phenomenon, this paper proposes a new trajectory for AI research—one that respects the complexity of its subject and strives to mirror the richness of human cognition and society. The following sections explore how this interdisciplinary model can be operationalized and what challenges and opportunities it presents for the future of AI[11].

Theoretical Integration and Cognitive Plausibility in AI Design:

The development of intelligent systems has often relied on abstraction and simplification. While such strategies have produced functional models and useful applications, they may fall short of capturing the full depth of what it means to be intelligent[12]. Theoretical integration across disciplines allows for a more comprehensive understanding of intelligence, offering models that are not only computationally efficient but also cognitively plausible. Cognitive science, for instance, provides well-established theories about attention, memory, perception, and reasoning that can serve as foundational elements for designing AI systems that better mimic human-like intelligence[13].

One key insight from cognitive psychology is that intelligence is not solely about logical deduction or pattern recognition; it also involves heuristics, intuition, and adaptive behavior. These aspects are especially relevant in uncertain and dynamic environments where rigid rule-based systems often fail. Integrating these principles into AI architectures could enhance their flexibility and robustness[14]. For example, reinforcement learning, inspired by behavioral psychology, already incorporates trial-and-error mechanisms that mirror human learning to some extent. However, its alignment with actual cognitive processes remains partial. To deepen this alignment, researchers can explore hybrid models that combine symbolic reasoning with connectionist networks, thereby incorporating both rule-based logic and distributed representations[15].

Neuroscience adds another layer of richness to this framework. Brain-inspired architectures such as hierarchical temporal memory (HTM) and neuromorphic computing are designed to mimic the structure and function of the human brain. These models aim to replicate processes like sparse distributed representation, temporal pooling, and sequence learning. Although these efforts are still in their infancy, they hold promise for creating systems that learn and generalize in more human-like ways[16]. Moreover, the concept of embodiment, supported by both neuroscience and philosophy, posits that intelligence emerges not just from neural computation but also from the interaction between a body and its environment. This notion is supported by studies in developmental robotics, which show that motor skills and sensory feedback are essential for the development of higher cognitive functions[17].

Language, a cornerstone of human intelligence, also benefits from interdisciplinary research. Linguistics provides insights into syntax, semantics, and pragmatics, all of which are crucial for developing AI systems capable of true natural language understanding[18]. While large language models have made impressive strides, they often lack grounding and contextual awareness. Integrating linguistic theory with computational models could help address these deficiencies, fostering more coherent and context-aware AI communication[19].

The integration of these diverse theoretical perspectives enables a shift from narrow AI, focused on specific tasks, to more general and adaptable forms of intelligence. It also encourages a reevaluation of current benchmarks and evaluation metrics. Instead of measuring success solely through task accuracy or computational efficiency, interdisciplinary research advocates for metrics that assess adaptability, transfer learning, explainability, and social alignment[20].

This cognitive and theoretical grounding is not merely academic; it has profound practical implications. For instance, in fields like education and mental health, AI systems that can interpret human emotions, intentions, and learning styles can provide more personalized and effective support[21]. In autonomous systems, understanding context and human behavior can lead to safer and more intuitive interactions. As we push toward more autonomous and intelligent machines, grounding their design in a deep and diverse understanding of intelligence will be crucial for ensuring that they act in ways that are predictable, reliable, and aligned with human values[22].

Ultimately, the integration of cognitive plausibility into AI design encourages a paradigm shift—from building tools that simulate intelligence to developing partners that understand, learn, and collaborate in ways that resonate with human cognition and social norms[23].

Ethical Dimensions and Societal Alignment of Interdisciplinary AI:

While the technical and cognitive dimensions of AI are essential for its functionality, the ethical and societal dimensions are equally critical for its acceptability and long-term sustainability. AI technologies are not developed in a vacuum; they are embedded in socio-political contexts that shape and are shaped by their deployment[24]. An interdisciplinary framework enables a more nuanced engagement with these dimensions, drawing from ethics, sociology, law, political science, and anthropology to inform the responsible development of intelligent systems[25].

Ethical concerns in AI range from algorithmic bias and discrimination to transparency, accountability, and autonomy. These issues are especially salient when AI systems are used in high-stakes domains such as criminal justice, healthcare, and finance[26]. Bias in training data or model design can lead to discriminatory outcomes, disproportionately affecting marginalized communities. Addressing these challenges requires more than technical fixes; it demands a deeper understanding of social structures, historical inequalities, and normative values. Ethicists and social scientists can play a pivotal role in uncovering hidden assumptions and power dynamics embedded in AI systems[27].

Transparency and explainability are also crucial for building trust in AI. Users and stakeholders need to understand how decisions are made, particularly when those decisions have significant consequences. While explainable AI (XAI) offers tools for interpreting model outputs, it often falls short of providing meaningful explanations for lay users[28]. Here, interdisciplinary collaboration is vital. Insights from human-computer interaction, psychology, and design studies can help develop interfaces and explanation formats that are both accurate and accessible. Legal scholars can further clarify the standards for algorithmic transparency required by emerging regulations[29].

Another critical issue is the alignment of AI systems with human values and societal goals. This includes not only avoiding harm but also actively promoting well-being, justice, and inclusivity. The concept of value alignment, often discussed in AI safety literature, can benefit from engagement with moral philosophy and normative ethics. For example, debates around utilitarianism versus deontology can inform the design of ethical decision-making frameworks in autonomous systems. Cultural anthropology and comparative religion can offer perspectives on value pluralism, ensuring that AI systems are sensitive to diverse moral and cultural contexts[30].

Societal alignment also involves participatory design and governance. Rather than treating users as passive recipients of technology, interdisciplinary AI research encourages co-design approaches where communities are involved in shaping the systems that affect them. This fosters not only better system design but also greater legitimacy and public trust. Public policy scholars can help design institutional mechanisms for AI oversight, while political theorists can contribute to debates on democracy, power, and accountability in AI governance[31].

Furthermore, an interdisciplinary perspective encourages reflection on the long-term implications of AI. What kind of society are we building with intelligent machines? How do AI systems reshape labor markets, education, and interpersonal relationships? These are questions that extend beyond engineering and require sustained dialogue among diverse stakeholders[32].

In sum, addressing the ethical and societal dimensions of AI is not a secondary concern but a foundational aspect of its design and deployment. An interdisciplinary framework makes it possible to anticipate unintended consequences, mitigate risks, and design AI systems that are not only intelligent but also just, inclusive, and aligned with the common good.

Conclusion

Rethinking intelligence through an interdisciplinary lens offers a path toward AI systems that are more cognitively grounded, ethically sound, and socially aligned. By integrating insights from across the sciences and humanities, we can move beyond narrow technical definitions and embrace a more holistic understanding of what it means to build truly intelligent and trustworthy machines.

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