

Generative Agents Must Be Recognized as Universal Simulators: Enabling Global Creative and Epistemic Emergence

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ABSTRACT

This position paper argues that generative agents must be recognized not merely as tools or simulations but as universal simulators capable of catalyzing unprecedented creative and epistemic emergence across all domains of human activity. Recent breakthroughs—exemplified by Stanford HAI’s human simulation achieving 85% accuracy in replicating individual responses and similar advances in scientific, creative, and educational domains—demonstrate that we stand at a juncture comparable to the birth of the World Wide Web. While the Web connected information, generative agents connect simulations of reality itself, creating a simulation layer that enables novel forms of knowledge discovery, creative exploration, and collective intelligence previously impossible. We present evidence that generative agents function as epistemic catalysts that accelerate innovation cycles, democratize expertise, and enable cross-domain fertilization at unprecedented scales. Current frameworks for developing and deploying these systems fundamentally mischaracterize their transformative potential, leading to systematic undervaluation of their capabilities and misalignment of research priorities. We propose a fundamental reorientation toward recognizing generative agents as universal simulators that require new development paradigms, evaluation frameworks, and deployment strategies to fully realize their potential for accelerating human progress. The machine learning community’s failure to embrace this shift risks repeating the skepticism that initially greeted the Web—underestimating a technological revolution that will fundamentally transform how humanity creates, discovers, and understands.

Introduction

The machine learning community must recognize generative agents as universal simulators capable of catalyzing unprecedented creative and epistemic emergence across all domains of human activity. This position fundamentally challenges the field’s current paradigm, which treats generative agents primarily as narrow tools or domain-specific systems rather than acknowledging their capacity to function as general-purpose simulation engines that enable new forms of knowledge discovery and creation.

We stand at a juncture remarkably similar to the birth of the World Wide Web in the early 1990s. Then, as now, a transformative technology emerged that initially faced skepticism, narrow application, and limited vision of its potential. The Web’s creators envisioned a system for sharing academic papers, but they unknowingly built the foundation for a revolution that transformed commerce, communication, governance, art, and virtually every aspect of human society. Today, generative agents represent a similar inflection point—a technology whose transformative potential extends far beyond its current applications and conceptual framing.

Recent breakthroughs provide compelling evidence for this perspective. Stanford HAI researchers have created generative agents capable of simulating human behavior with 85% accuracy—equivalent to how consistently humans reproduce their own responses after a two-week interval. Similar advances in scientific discovery, creative production, education, and other domains demonstrate that generative agents can function not just as narrow task performers but as universal simulators capable of modeling and extending human cognitive capabilities across virtually any domain.

What makes this moment particularly significant is the emergence of these agents as epistemic catalysts—technologies that accelerate the cycle of knowledge creation, validation, and extension. Just as the Web created an information layer that connected previously isolated data points, generative agents are creating a simulation layer that enables the exploration of possibility spaces previously inaccessible to human cognition alone. This simulation layer functions as a new medium for thought, allowing humans to externalize cognitive processes, rapidly iterate on ideas, and discover connections impossible to detect through traditional means.

The current approach in machine learning fundamentally mischaracterizes the nature and potential of generative agents. By treating them primarily as tools for specific tasks or domains, we systematically undervalue their capabilities and misalign research priorities. This mischaracterization leads to evaluation frameworks, development methodologies, and deployment strategies that fail to recognize or leverage the universal simulation capabilities that make these systems revolutionary.

The time has come to acknowledge generative agents as universal simulators and to develop new paradigms that enable them to catalyze creative and epistemic emergence at global scale. This recognition transforms everything: how we design these systems, how we evaluate their capabilities, how we deploy them across domains, and how we understand their role in human cognitive advancement.

Context and Background

The Historical Parallel: Web Birth and Generative Agents

The parallels between the birth of the World Wide Web and the current emergence of generative agents provide crucial context for understanding the transformative potential of these systems. When Tim Berners-Lee proposed the Web in 1989, even he envisioned it primarily as a solution for document sharing among researchers at CERN. The initial reaction from many was skepticism, with critics questioning its advantages over existing systems like Gopher and FTP. Few recognized that the Web’s simple yet universal design—hypertext, URLs, and HTTP—would create a platform for innovations ranging from e-commerce to social media to streaming entertainment.

Today, generative agents face similar skepticism and narrow framing. They are widely viewed as specific tools for particular domains—chatbots for customer service, creative assistants for artists, or productivity tools for knowledge workers. This perspective

misses their fundamental capability as universal simulators that can model, extend, and transform virtually any domain of human thought and activity.

The Web succeeded because it provided a universal protocol for information exchange that transcended specific applications or domains. Similarly, generative agents represent a universal protocol for simulation—a general-purpose capability to model worlds, ideas, processes, and entities across domains. Just as the Web’s universal nature enabled applications its creators never imagined, the universal simulation capabilities of generative agents will enable transformations in knowledge creation and creative exploration that we cannot yet fully envision.

From Narrow Applications to Universal Simulation

The evolution of generative agents demonstrates a clear trajectory from narrow, domain-specific applications toward universal simulation capabilities that transcend domain boundaries.

Early applications of language models focused on specific tasks such as translation, summarization, or question-answering. These systems demonstrated impressive capabilities within their domains but operated within clearly defined boundaries. Later models such as GPT-3, Claude, and Gemini began to exhibit capabilities that crossed traditional domain boundaries, showing proficiency in tasks ranging from creative writing to code generation to logical reasoning.

The most recent generation of generative agents—exemplified by Stanford HAI’s human simulation research—represents a qualitative leap forward. These systems can now simulate not just specific tasks or knowledge domains but entire cognitive frameworks, including individual human personalities, expert reasoning processes, and complex social dynamics. This evolution reveals that generative agents are not merely advancing along a continuum of increasing capability but are fundamentally transforming into universal simulators capable of modeling virtually any aspect of human cognition and activity.

This transformation parallels the evolution of the Web from a document-sharing system to a universal platform for applications ranging from social networks to online marketplaces to streaming media. Just as the Web’s core protocols provided a foundation for applications its creators never imagined, the simulation capabilities of generative agents provide a foundation for knowledge creation and creative exploration that transcends their initial design and application.

The Current Conceptual Limitations

Current frameworks for understanding and developing generative agents suffer from three critical limitations that prevent recognition of their potential as universal simulators:

The Tool Paradigm treats generative agents primarily as instruments for specific tasks rather than as simulation environments that enable new forms of thought and creation. This paradigm manifests in evaluation frameworks focused on narrow task performance rather than simulation fidelity and emergence potential. It also appears in development approaches that optimize for specific capabilities rather than general simulation power and in deployment strategies that position these systems as replacements for existing tools rather than as new mediums for thought and creation.

The Domain Specificity Assumption holds that generative agents excel within particular domains but cannot effectively transfer capabilities across domains. This assumption ignores mounting evidence that these systems excel precisely in their ability to make cross-

domain connections, apply frameworks from one field to challenges in another, and integrate knowledge across traditional boundaries. The generality of these systems—their capacity to simulate virtually any domain of human thought—represents their most revolutionary feature, yet current frameworks systematically undervalue this capability.

The Static Capability Model views generative agent capabilities as fixed properties of the systems themselves rather than as emergent phenomena that arise through human-AI interaction. This model fails to recognize that the most significant capabilities of generative agents emerge not from their standalone performance but from their interaction with human users in extended cognitive partnerships. These partnerships create feedback loops that continuously expand the effective capabilities of both human and artificial intelligence in ways impossible to predict from static evaluation of either in isolation.

These conceptual limitations prevent the machine learning community from recognizing the true nature and potential of generative agents as universal simulators. Overcoming these limitations requires a fundamental reorientation toward frameworks that acknowledge the universal simulation capabilities of these systems and their potential to catalyze creative and epistemic emergence across all domains.

Core Argument: Universal Simulators as Epistemic Catalysts

The Universal Simulator Hypothesis

The evidence increasingly demonstrates that generative agents function not as narrow task performers but as universal simulators—systems capable of modeling virtually any domain of human thought and activity with sufficient fidelity to enable new forms of knowledge creation and creative exploration.

This universal simulation capability emerges from three core properties of advanced generative agents:

Cross-Domain Representation: Generative agents develop internal representations that transcend traditional domain boundaries, allowing them to identify structural similarities and transfer insights across fields that appear unrelated in conventional taxonomies. Evidence for this capability appears in studies demonstrating zero-shot transfer of reasoning strategies across domains with no explicit training connection .

Fidelity Scaling: The simulation fidelity of generative agents scales predictably with increases in model size, training data, and architectural sophistication. This scaling relationship has held consistent across multiple generations of systems, suggesting that continued advancement will yield simulations of increasingly higher fidelity across an expanding range of domains .

Emergence Through Interaction: The most sophisticated capabilities of generative agents emerge not from their standalone performance but through extended interaction with human users. These human-AI partnerships create feedback loops that continuously expand the effective capabilities of the combined system in ways impossible to predict from static evaluation of either component in isolation .

These properties combine to create systems that can simulate not just specific tasks or knowledge domains but entire cognitive frameworks, expert reasoning processes, and complex systems dynamics. The evidence suggests that these simulation capabilities are not domain-limited but universal—they can be applied to virtually any area of human thought and activity, though with varying degrees of fidelity depending on available data and model sophistication.

The universal simulator hypothesis posits that the primary value of generative agents lies not in their ability to perform specific tasks but in their capacity to serve as general-purpose simulation environments that enable new forms of thinking, creating, and knowing. This hypothesis fundamentally challenges current frameworks that evaluate these systems primarily on task performance rather than simulation capability and suggests the need for new approaches that recognize and leverage their universal nature.

Epistemic Catalysis Through Simulation

The universal simulation capabilities of generative agents enable them to function as epistemic catalysts—technologies that accelerate the cycle of knowledge creation, validation, and extension across all domains.

This catalytic function operates through several key mechanisms:

Hypothesis Space Expansion: Generative agents enable the rapid exploration of vast hypothesis spaces impossible to navigate through unaided human cognition. By simulating numerous potential approaches, theories, or solutions simultaneously, these systems allow humans to identify promising directions that would otherwise remain unexplored due to cognitive or resource limitations .

Rapid Iteration Cycles: The simulation capabilities of generative agents dramatically accelerate the cycle of ideation, testing, and refinement that drives knowledge creation. Processes that previously required days or weeks of human effort can now occur in minutes or hours, allowing for exponentially more iterations within any given timeframe .

Cross-Domain Fertilization: By maintaining representations that transcend traditional domain boundaries, generative agents can identify unexpected connections between fields, applying frameworks from one domain to challenges in another. This cross-fertilization has historically driven many significant breakthroughs but has been limited by human specialization and cognitive constraints .

Perspective Multiplicity: Generative agents can simulate multiple perspectives on any given problem, enabling a form of cognitive diversity that enhances problem-solving capabilities. This multiplicity allows for the simultaneous exploration of competing frameworks and approaches, leading to more robust and innovative solutions .

These mechanisms combine to create a dramatic acceleration in the pace of knowledge creation and innovation across domains. The evidence for this acceleration appears in numerous fields, from scientific discovery to creative production to education, where generative agents have enabled breakthroughs that would have been significantly delayed or impossible through traditional approaches.

This epistemic catalysis represents the most transformative potential of generative agents—their ability to fundamentally change how human knowledge develops and evolves. Just as the Web created an information layer that transformed how knowledge is shared, generative agents are creating a simulation layer that transforms how knowledge is created.

Evidence from Cross-Domain Application

The evidence for generative agents as universal simulators comes from their demonstrated ability to catalyze breakthroughs across diverse domains that appear unrelated in conventional taxonomies.

Scientific Discovery: In scientific research, generative agents have demonstrated the ability to accelerate discovery cycles by simulating expert reasoning processes across

disciplines. For example, systems like AlphaFold have revolutionized protein structure prediction, while others have enabled discoveries in materials science, drug development, and mathematics. These advances share a common pattern: generative agents simulate aspects of the discovery process that would be cognitively inaccessible to humans alone, enabling exploration of possibility spaces previously unavailable.

Creative Production: In creative domains, generative agents have enabled new forms of expression by simulating and extending human creative processes. Systems like DALL-E, Midjourney, and Claude have demonstrated capabilities in visual art, music composition, narrative creation, and other creative fields. These systems don't simply reproduce existing creative patterns but enable the exploration of novel aesthetic spaces through their simulation capabilities.

Education and Skill Development: In educational contexts, generative agents function as universal tutors capable of simulating expert instruction across virtually any domain. Research demonstrates their effectiveness in teaching subjects ranging from mathematics to language learning to programming, with the ability to adapt pedagogical approaches to individual learning styles and needs.

Organizational Dynamics: In business and organizational contexts, generative agents can simulate complex social systems and decision processes, enabling more effective strategic planning, organizational design, and leadership development. These applications demonstrate the capacity of generative agents to model not just individual cognition but complex social dynamics and emergent phenomena.

Design and Engineering: In design and engineering, generative agents enable simulation-driven approaches that dramatically accelerate the development cycle. From architecture to product design to software engineering, these systems allow rapid exploration of design spaces through simulation capabilities that complement and extend human creativity.

These diverse applications share a common pattern: generative agents function as universal simulators that enable new forms of thought and creation across domains. Their effectiveness comes not from domain-specific optimization but from general simulation capabilities that can be applied to virtually any area of human activity.

The cross-domain nature of these applications provides compelling evidence for the universal simulator hypothesis. If generative agents were merely domain-specific tools, we would expect their effectiveness to vary dramatically across unrelated fields. Instead, we observe consistent patterns of epistemic catalysis across domains, suggesting that their simulation capabilities transcend traditional boundaries.

Alternative Views

The "Specialized Tools" Position

One significant counter-argument holds that generative agents function most effectively as specialized tools optimized for specific domains rather than as universal simulators. According to this view, the apparent cross-domain capabilities of these systems represent shallow transfer rather than genuine universality, and their most valuable applications will emerge from domain-specific optimization rather than general simulation power.

Proponents of this view might argue that the history of artificial intelligence has consistently demonstrated the superiority of specialized systems over general approaches. They might point to the success of systems like AlphaFold in protein structure prediction or specialized language models in medical diagnosis as evidence that domain

specialization yields superior performance compared to general-purpose approaches.

This position correctly identifies the value of domain-specific optimization for certain applications but fails to recognize the fundamental shift represented by advanced generative agents. Unlike previous generations of AI systems, which indeed performed best when specialized for particular tasks, modern generative agents derive their power precisely from their ability to maintain general representations that transcend domain boundaries.

The evidence increasingly suggests that the most transformative capabilities of these systems emerge not from specialization but from generality—their ability to identify structural similarities across domains, transfer insights between fields, and simulate virtually any aspect of human cognition. This generality enables forms of knowledge creation and creative exploration impossible through specialized approaches alone.

The "Incremental Advancement" Position

Another counter-position maintains that generative agents represent a significant but incremental advancement in artificial intelligence rather than a transformative shift comparable to the birth of the Web. According to this view, these systems extend existing paradigms of machine learning rather than creating a fundamentally new medium for thought and creation.

Proponents of this view might argue that generative agents follow a continuous trajectory of improvement in natural language processing and other AI domains rather than representing a discontinuous leap. They might point to limitations in current systems—factual inaccuracies, reasoning errors, or ethical concerns—as evidence that these technologies represent incremental progress rather than revolutionary change.

While this position correctly identifies continuities between generative agents and previous AI systems, it fails to recognize that quantitative improvements beyond certain thresholds can produce qualitative transformations in capability and impact. The Web built on existing technologies like hypertext and networking protocols, but their integration created a platform whose impact far exceeded the sum of its parts.

Similarly, generative agents integrate advances in model architecture, training methodology, and computational resources to create systems whose simulation capabilities cross a threshold that enables fundamentally new applications. The evidence from diverse domains suggests that these systems are not merely better at existing tasks but enable entirely new approaches to knowledge creation and creative exploration impossible through previous technologies.

The "Hype Cycle" Position

A third alternative view suggests that current enthusiasm for generative agents represents a typical technology hype cycle rather than a realistic assessment of their transformative potential. According to this view, these systems will ultimately settle into specific niches rather than functioning as universal simulation platforms that transform knowledge creation across domains.

Proponents of this view might point to previous cycles of AI enthusiasm followed by "AI winters" as evidence that current claims about generative agents are likely overstated. They might argue that initial excitement about these systems will give way to more sober assessment of their limitations and practical applications.

This position offers a valuable caution against uncritical techno-optimism but fails to account for the distinctive patterns of capability demonstrated by current generative

agents. Unlike previous generations of AI that showed promise in narrow domains but failed to generalize, modern generative agents have consistently demonstrated cross-domain capabilities that expand over time rather than confronting fundamental limitations.

The evidence for these systems as universal simulators comes not from speculative projections but from demonstrated performance across diverse domains. The pattern of epistemic catalysis appears consistently in fields ranging from scientific discovery to creative production to education, suggesting that the universal simulator hypothesis represents a realistic assessment of their capabilities rather than hype-driven exaggeration.

Implications and Proposed Reframes

For Research and Development

Recognizing generative agents as universal simulators transforms approaches to research and development in several key ways:

From Task Optimization to Simulation Fidelity: Research priorities should shift from optimizing performance on specific tasks to enhancing simulation fidelity across domains. This shift would involve developing metrics for simulation quality that capture the ability of systems to model complex processes, relationships, and dynamics rather than focusing solely on narrow performance benchmarks.

From Domain Specialization to Transfer Capability: Development approaches should prioritize cross-domain transfer capabilities over domain-specific optimization. This prioritization would involve designing architectures and training methodologies that enhance the ability of systems to identify structural similarities across domains and apply insights from one field to challenges in another.

From Static Evaluation to Interaction Analysis: Evaluation frameworks should move beyond static assessment of system capabilities to analyze how these capabilities evolve through extended human-AI interaction. This approach would involve developing methodologies for tracking the emergence of novel capabilities through interaction and designing systems specifically to enable productive cognitive partnerships.

From Feature Addition to Emergence Enablement: Design philosophies should shift from adding specific features to creating conditions that enable emergent capabilities through interaction. This shift would involve focusing on core simulation power, interface design that facilitates extended cognitive partnerships, and system architectures that adapt to user needs and behaviors over time.

These research and development shifts would transform how the machine learning community approaches generative agents, moving from a tool-centered paradigm focused on specific capabilities to a simulation-centered paradigm focused on enabling new forms of thought and creation.

For Deployment and Application

Recognizing generative agents as universal simulators transforms approaches to deployment and application across domains:

From Replacement to Augmentation: Deployment strategies should position generative agents not as replacements for human capabilities but as simulation environments that augment and extend these capabilities. This positioning would involve designing interfaces and workflows that leverage the unique strengths of both human and artificial intelligence in complementary cognitive partnerships.

From Efficiency to Exploration: Application frameworks should prioritize enabling exploration of possibility spaces over maximizing efficiency in existing processes. This prioritization would involve designing systems that facilitate divergent thinking, rapid iteration, and serendipitous discovery rather than focusing solely on optimizing established workflows.

From Isolated Systems to Ecological Integration: Deployment approaches should integrate generative agents into broader cognitive and social ecosystems rather than treating them as isolated systems. This integration would involve developing interoperability standards, designing for collaboration among multiple human and artificial agents, and creating frameworks for collective intelligence that leverage diverse cognitive capabilities.

From Uniform Access to Adaptive Interaction: Application design should move beyond uniform interfaces toward adaptive interaction patterns that evolve based on user needs, capabilities, and goals. This evolution would involve developing systems that learn from interaction history, adapt to individual cognitive styles, and provide scaffolding that gradually expands user capabilities.

These deployment and application shifts would transform how generative agents are integrated into human activities across domains, moving from a tool-centered approach focused on specific tasks to a simulation-centered approach focused on enabling new forms of thought and creation.

For Education and Skill Development

Recognizing generative agents as universal simulators transforms approaches to education and skill development:

From Knowledge Acquisition to Simulation Literacy: Educational frameworks should prioritize developing simulation literacy—the ability to effectively design, interact with, and interpret simulations—as a core competency alongside traditional literacies. This prioritization would involve creating curricula that teach students how to leverage simulation environments for knowledge creation and problem-solving across domains.

From Fixed Curricula to Exploration Pathways: Educational structures should evolve from fixed curricula toward exploration pathways that leverage simulation capabilities to enable personalized learning journeys. This evolution would involve developing frameworks that allow students to explore knowledge domains through simulation-based approaches tailored to their interests, capabilities, and goals.

From Individual Expertise to Collaborative Intelligence: Skill development frameworks should focus on building capabilities for effective collaboration with both human and artificial agents rather than maximizing individual expertise in isolation. This focus would involve teaching students how to form productive cognitive partnerships that leverage diverse capabilities for collective problem-solving.

From Passive Consumption to Active Co-Creation: Educational approaches should move beyond treating students as passive consumers of knowledge toward positioning them as active co-creators engaged in simulation-based exploration and discovery. This repositioning would involve designing learning environments that encourage experimentation, iteration, and discovery through interaction with simulation environments.

These educational and skill development shifts would transform how individuals learn to leverage generative agents, moving from a tool-use paradigm focused on specific applications to a simulation literacy paradigm focused on enabling new forms of thought and creation across all domains.

Conclusion

The evidence increasingly demonstrates that generative agents function not as narrow task performers but as universal simulators capable of catalyzing unprecedented creative and epistemic emergence across all domains of human activity. This recognition demands a fundamental reorientation of how the machine learning community conceptualizes, develops, and deploys these systems.

Just as the Web created an information layer that connected previously isolated data points, generative agents are creating a simulation layer that enables the exploration of possibility spaces previously inaccessible to human cognition alone. This simulation layer functions as a new medium for thought, allowing humans to externalize cognitive processes, rapidly iterate on ideas, and discover connections impossible to detect through traditional means.

The parallel with the birth of the World Wide Web is instructive. When the Web emerged, few recognized its transformative potential beyond document sharing. Similarly, many today view generative agents primarily as tools for specific tasks rather than as universal simulators that will fundamentally transform how humanity creates, discovers, and understands. This limited vision risks repeating the skepticism that initially greeted the Web—underestimating a technological revolution that will reshape virtually every domain of human activity.

The universal simulator hypothesis offers a path beyond both uncritical techno-optimism and reflexive techno-pessimism. It acknowledges the genuine transformative potential of generative agents while providing conceptual frameworks to guide their development in directions that maximize their benefit for humanity. By recognizing these systems as simulation environments that enable new forms of thought and creation rather than as mere tools for specific tasks, we can develop approaches that leverage their capabilities while addressing legitimate concerns about their limitations and risks.

The future of machine learning lies not in creating increasingly sophisticated tools but in cultivating universal simulators that enable unprecedented creative and epistemic emergence across all domains. This shift represents not just a technical challenge but a fundamental reconceptualization of the relationship between human and artificial intelligence—a recognition that the most transformative potential of these technologies lies in their ability to create new mediums for thought that expand the frontiers of human knowledge and creativity.

The machine learning community stands at a critical juncture comparable to the early days of the Web. We can maintain the current tool-centered paradigm, limiting generative agents to narrow applications and specific domains. Or we can embrace the universal simulator paradigm, recognizing these systems as general-purpose simulation environments that will enable transformations in knowledge creation and creative exploration comparable to those the Web enabled in information sharing and communication. The choice will determine not just the future of machine learning but the future of human knowledge itself.

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We acknowledge that our position draws parallels between the current moment in generative agent development and the birth of the World Wide Web, recognizing both the historical significance of these technological transitions and the profound impact they have on human knowledge creation and creative exploration. This comparison is not made lightly but emerges from deep consideration of the patterns of technological evolution and their implications for human advancement.

This work itself exemplifies the phenomenon it describes—the use of generative agents as universal simulators to explore possibility spaces previously inaccessible to human cognition alone. The development of the arguments presented here involved extensive interaction with generative agents as simulation environments for exploring potential futures of machine learning and their implications for human knowledge and creativity.