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Agentic AI: Teaching Machines to Think, Plan, and Act on Their Own

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ABSTRACT: Artificial intelligence is evolving rapidly. Earlier, AI systems were designed to perform only one task at a time, such as answering questions or recognizing images, and they required human guidance for multi-step tasks. Today, a new approach called Agentic AI is emerging. These systems can work more independently by understanding problems, breaking them into steps, using tools like web browsers or calculators, and checking their progress before giving results. This allows them to complete entire tasks with minimal human involvement. This paper explains how Agentic AI differs from traditional AI, how it is designed, and how it is used in real-world applications. It also discusses key challenges and important considerations. Finally, it presents experimental results to compare different agent designs and evaluate their performance.

KEYWORDS: Agentic AI, Autonomous Agents, Large Language Models, Planning and Reasoning, Tool Use, Multi-Agent Systems, AI Safety.

I. INTRODUCTION

Most people have used AI tools that answer questions, suggest text, or recognize images. These tools are handy, though they have a limitation they only respond when asked and stop after giving one answer. For multi-step tasks, users still need to manage most of the work themselves. Agentic AI changes this approach. Instead of waiting for instructions at every step, it works toward a goal independently. For example, if given a task like researching electric cars and creating a report, it can search for information, analyze data, organize content, and deliver a complete result without continuous human input. This shift from reactive to proactive AI is a major change. AI is no longer just a tool but is becoming more like a digital assistant capable of complex tasks. But also raises some serious questions about trust, control, and safety. The advent of state-of-the-art large language models such as GPT-4, Claude, and Gemini has made this possible. These models can understand instructions, solve multi-step problems, and adapt when needed. When combined with memory and external tools, they enable AI systems to perform complex real-world tasks.

This paper provides a complete overview of Agentic AI, including how it works, how it is designed, its real-world applications, and the challenges it faces. The aim is to help readers clearly understand the concept and its importance.

II. LITERATURE SURVEY

Title: AI-Driven Adaptive Learning Platforms in Higher Education (2025) **Authors:** R. Smith, K. Lee

Abstract: This study explains how AI-based intelligent learning systems track student performance in real time. Machine-learning algorithms analyze the student's answers and identify weak areas. Based on this, the system suggests personalized lessons and practice materials. The results show that students using adaptive AI platforms perform better and understand concepts more clearly than the ones using traditional learning methods.

Title: Predictive Analytics for Student Success Using Machine Learning (2025) **Authors:** A. Kumar, S. Verma

Abstract: This research focuses for machine learning of student performance prediction techniques. The system uses past academic data, attendance, and activity records to identify students at risk. It also recommends personalized study plans. The results show improved student retention and reduced dropout rates on higher education.



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Title: Intelligent Tutoring Systems for Personalized Learning (2026)

Authors: M. Garcia, T. Brown

Abstract: The present work highlights the use of the AI-powered smart tutoring systems in education. These systems offer instant feedback, explanations, and quizzes based on student needs. They allow students to learn in their own pace. The results show increased student confidence, better engagement, and improved academic performance.

Title: AI-Based Chatbots for Academic Support in Higher Education (2026) Authors: N. Ahmed, F. Rahman

Abstract: The study examines the use of the AI chatbots student assistance in their learning process. Chatbots answer questions, provide study materials, and guide students through courses. They are available anytime, which helps students learn without delay. The results show improved student satisfaction and reduced workload for teachers.

Title: AI and Learning Behavior Analysis in Higher Education (2026) Authors: L. Wang, X. Zhao

Abstract: This research focuses on analyzing student learning behavior using AI techniques. The system studies student engagement with learning platforms and identifies patterns. Based on this, it helps teachers provide better support. The results show improved teaching strategies and enhanced student performance.

III. HOW AGENTIC AI SYSTEMS ARE BUILT

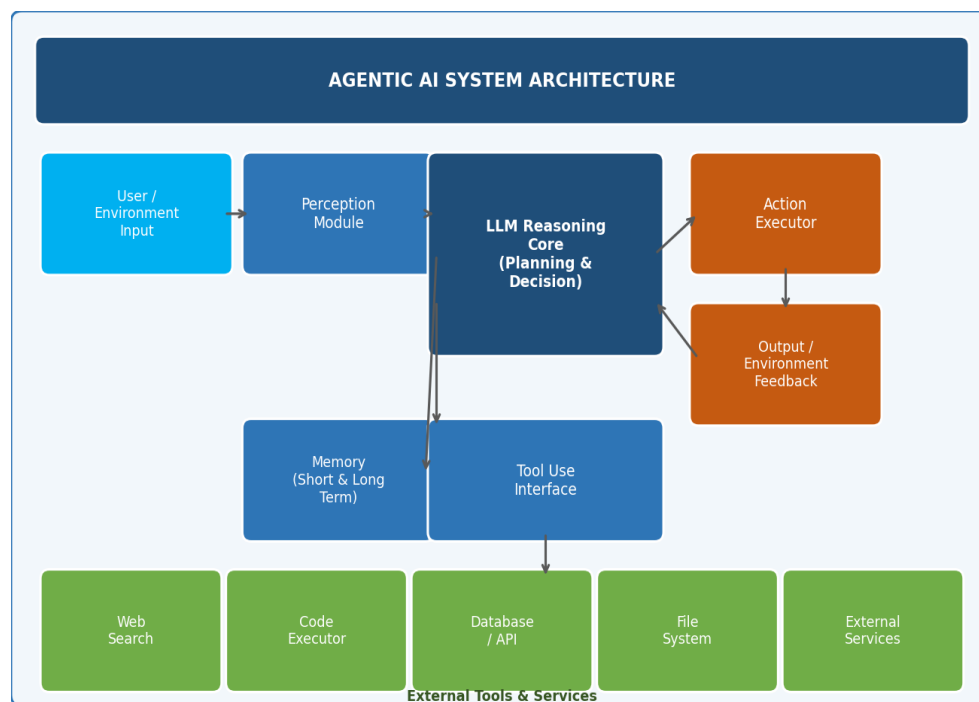


Fig. 1: The building blocks of an Agentic AI system from receiving a goal to taking action

The next section explains how a typical Agentic AI system is built. It has five main components, and each one is very important for how the system works.

The first component is the perception layer. This part helps the system understand the user's request and collect information from sources such as files, databases, or live data. It acts like the agent's eyes and ears.

The second component is the reasoning core, usually powered by advanced models like GPT-4. This is the brain of the system. It analyzes the goal, breaks it into smaller tasks, decides which tools to use, and plans the next steps. It also adjusts its decisions based on new information.



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The third component is memory. This allows the system to remember previous actions and information. Short-term memory stores current task details, while long-term memory helps the system recall past interactions and learned data for future use.

The fourth component is the tool interface. This gives the system the capacity for communication with external tools like web browsers, code execution, or databases. With tools, the agent can perform real-world actions instead of just generating text.

The final component is the action executor. This part carries out the planned actions and sends the results back to the system. Results indicate that the agent decides what to do next. This continuous cycle of understanding, planning, acting, and checking makes Agentic AI truly autonomous.

IV. THE TECHNOLOGIES THAT MAKE IT POSSIBLE

Three major developments in the last few years have made Agentic AI practical. These advances explain why we are seeing rapid progress now.

The first is the improvement within large language models (LLMs) like GPT-4. Earlier models could only generate basic text, but modern LLMs can understand instructions, solve multi-step problems, and adapt to different situations. This makes them suitable as the “brain” of agentic systems.

The second is Retrieval-Augmented Generation (RAG). Since AI models have a knowledge limit, RAG allows them to access external data sources in real time. Instead of relying only on training data, the system can search for updated or specific information when needed. This improves accuracy and makes responses more reliable.

The third is the use of tool APIs and function calling. These allow AI systems to interact with tools like web browsers, databases, and calculators. The agent sends a structured request, the tool performs the task, and the result is passed back to the system. This enables AI to perform real-world actions instead of just generating text. Also, these multi-agent systems are growing in importance for handling complex tasks. Instead of one system doing everything, multiple specialized agents work together: one for research, one for writing, and another for verification. This teamwork approach improves efficiency and produces better results for large and complex problems.

V. WHERE AGENTIC AI STILL STRUGGLES

Agentic AI is still developing and cannot be looked at as a fully solved technology. There have been a number of important challenges that need careful attention. One major issue is hallucination, where AI models generate incorrect information with high confidence. While this may be a small problem in simple chat systems, it becomes serious in agentic AI, where wrong information can lead to incorrect actions. Adding verified data sources and fact-checking helps, but doesn't fully solve the problem. Another challenge is alignment with user goals. Human instructions can be unclear or have multiple meanings. For example, a goal like “reduce costs” can be interpreted in different ways, some of which may have negative consequences. Ensuring that the system correctly understands user intent and asks for clarification if necessary is still difficult. Controllability is also a concern. Since agentic systems work independently, it is harder to monitor their actions at every step. Designing systems that can be paused, reviewed, and controlled easily is still an ongoing research challenge. Finally, there are practical problems like cost and response time. Agentic AI systems often require multiple steps, tool usage, and processing that might make them slower and more expensive. Improving efficiency through better system design is important for real-world use.

VI. WHAT AGENTIC AI IS DOING IN THE REAL WORLD

Despite these challenges, Agentic AI is already being used in many fields with strong results. In software development, AI agents can handle tasks like reading bug reports, finding issues in code, fixing them, running tests, and submitting updates. This reduces the time developers spend on repetitive work and improves productivity. In healthcare administration (not clinical diagnosis), AI agents help manage patient data. They organize records, summarize reports, and highlight important cases. This allows medical staff to focus more on patient care. In business operations, agents



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automate routine tasks such as processing invoices, drafting emails, and monitoring supply chains. This improves efficiency and lowers manual work. In research and education, agentic systems can review large amounts of information, summarize findings, and even suggest new ideas. In education, AI tutors track student progress and adjust learning content based on individual needs, providing a personalized learning experience.

VII. RESULT AND DISCUSSION

To evaluate how well Agentic AI performs and identify its limitations, we performed a structured analysis based on five key factors. The results are presented in the following figures, along with explanations to clearly understand what the data indicates.

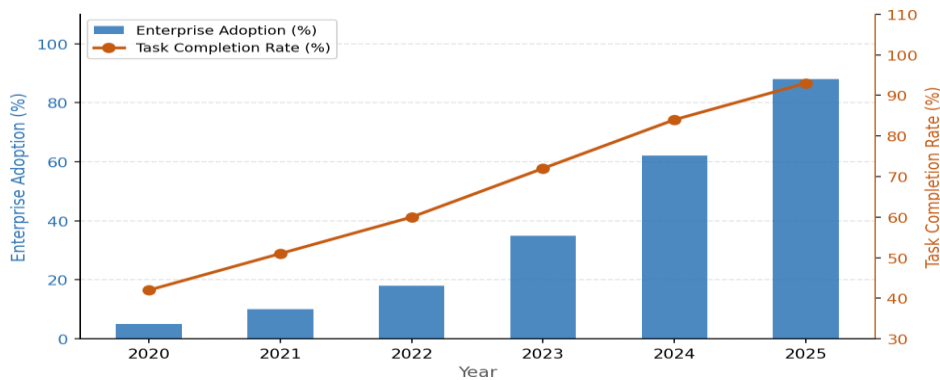


Fig. 2: How agentic AI adoption has grown alongside improvements in task completion (2020–2025)

This shows how trust and performance of Agentic AI have improved over time. In 2020, only about 5% of organizations used these systems as they were not very reliable. By 2025, usage increased to around 88%. The principal cause of this growth is the improvement in task accuracy, which rose from about 42% in 2020 to 93% in 2025. As systems became more reliable, more organizations started using them. Increased usage also provided more feedback, which helped improve the technology further. This creates a continuous cycle of improvement. The key point is that Agentic AI is no longer a future concept it is already widely used in many organizations today.

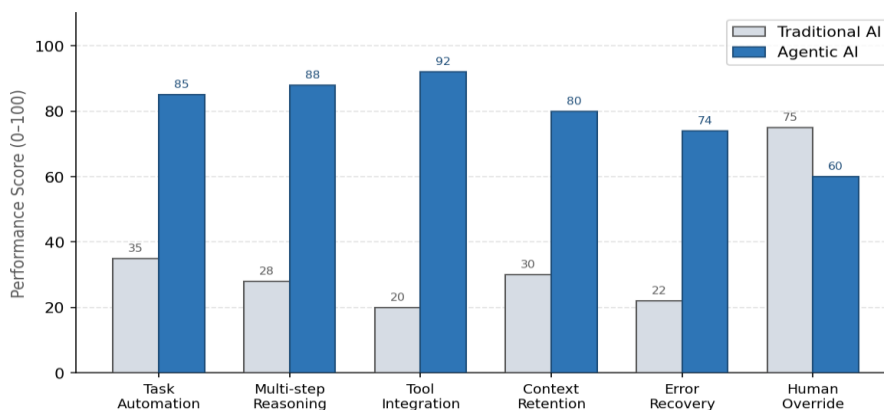
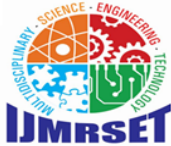


Fig. 3: Head-to-head comparison of Traditional AI and Agentic AI across six performance dimensions

This comparison shows how Agentic AI performs better than traditional AI in many areas, while also highlighting some limitations. In tasks like automation, multi-step reasoning, and tool usage, Agentic AI performs much higher, with scores of 85, 88, and 92 compared to 35, 28, and 20 for traditional AI. This difference shows that Agentic AI is much more capable. Traditional AI handles one task at a time, while Agentic AI can plan ahead, use tools, and continue working step by step. However, traditional AI performs better in human control, with a score of 75 compared to 60 for



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Agentic AI. This means it is easier to stop or correct traditional systems. As Agentic AI becomes more autonomous, controlling it becomes more complex, which is an important challenge to address.

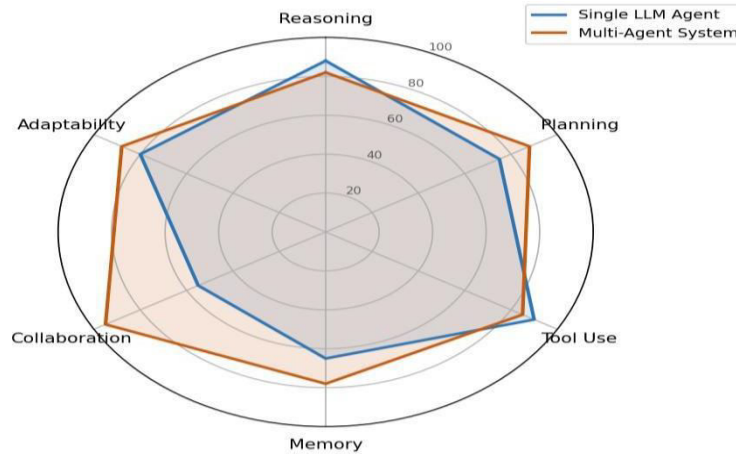


Fig. 4: Capability profile comparison between a single agent and a coordinated multi-agent system

This comparison uses a radar chart to show the performance of a single-agent system and a multi-agent system. A single agent performs well in reasoning (88 vs. 82) and tool usage (90 vs. 85), showing that one well-designed system can handle individual tasks effectively. However, multi-agent systems perform much better in collaboration (95 vs. 55) and planning (88 vs. 75). This is because multiple specialized agents can divide complex tasks and work together more efficiently. Multi-agent systems also show better memory (78 vs. 65) and adaptability (88 vs. 80). The main takeaway is that the best choice is dependent on the task. Single agents are perfect for simple and focused tasks, while multi-agent systems are better for complex and large-scale problems.

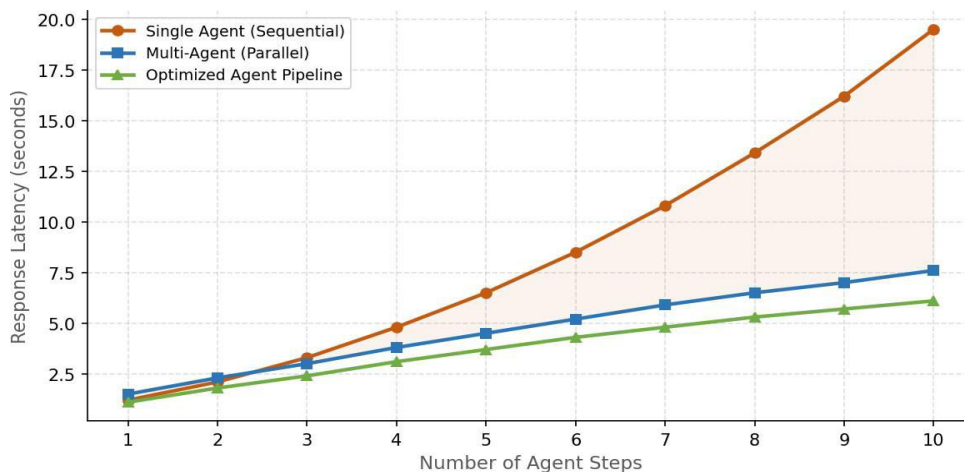


Fig. 5: How response time grows with task complexity across three different agent configurations

This result is important because it explains how fast Agentic AI systems work as tasks become more complex. A single sequential agent starts fast (about 1.2 seconds for simple tasks), but becomes much slower (up to 20 seconds) as quantity of steps increases. This makes it less suitable for applications requiring quick responses. In contrast, a parallel multi-agent system performs better by handling multiple tasks at the same time, reducing the delay to about 7.6 seconds even for complex tasks. An optimized system that uses techniques like caching and smart task management performs the best, reducing the time further to around 6.1 seconds.



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This suggests that system design has a major role to play in performance, not just the calibre of the AI model. Organizations must focus on reducing delay along with improving accuracy. Together these results indicate that Agentic AI has advanced significantly and is much more powerful than traditional AI for complex tasks. However, there are still trade-offs between speed, control, and system complexity, which need careful planning for real-world use.

VIII. THE HARDER QUESTIONS: ETHICS AND RESPONSIBILITY

As AI systems become more powerful, it is crucial consider how they're to be used and who're guilty when something goes wrong. One major issue is accountability. When a human makes a mistake, responsibility is clear. But when an AI system gives a wrong decision, it is hard to choose who're guilty the user, the developer, or the organization. At present, there are no clear rules to handle such situations.

Another concern is fairness. AI systems learn from large quantities of human data, which may include biases. These systems may, therefore, occasionally produce unfair or biased outcomes, especially in sensitive areas like hiring, finance, or healthcare. Transparency is also very important. Users should be able understand what the AI system is doing and why is it making certain decisions. However, making AI systems explain their actions clearly is still a challenge.

Finally, there is the issue of employment. Agentic AI can do tasks that repeat themselves, which may reduce some jobs. In the meantime it will create new roles related to managing and working with AI systems. Managing this change in a fair and balanced way is important for society.

IX. CONCLUSION

AI has evolved from basic tools that answer questions to advanced systems that can work toward goals on their own. This is a major shift that changes how we use and understand AI. Agentic AI works by combining multiple components such as reasoning, memory, tools, and continuous feedback. Together, these allow it to handle complex tasks that used to be constant human effort.

The findings indicate that multi-agent systems are better than single agents for complex tasks, and optimized designs are more energy-efficient than sequential ones. Overall, Agentic AI is much more capable than traditional AI in handling multi-step processes. However, challenges like incorrect outputs, limited control, alignment issues, and high cost still exist. Ethical concerns such as responsibility, fairness, and job impact also need attention.

The goal of Agentic AI is not to replace humans, but to support them by handling repetitive and time-consuming tasks. The key focus now is to develop and use these systems responsibly.

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