



# International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*



**Impact Factor: 8.524**

**Volume 14, Issue 1, January 2025**

# Agentic AI: A Paradigm for Autonomous Decision-Making

Meethun Panda

Associate Partner, Enterprise Technology, Data & AI at BAIN & COMPANY, EMEA – Dubai, Jumeirah, Dubai

**ABSTRACT:** In this paper, we explore the paradigm of Agentic AI, where generative AI systems are not limited to generate responses but become the agent in autonomous and context aware decisions. It discusses defining characteristics, architectural components, and the ethical considerations; real world applications included in autonomous vehicles, collaborative robots and personalized services. Challenges such as scalability and interpretability, as well as future opportunities such as interdisciplinary research and general-purpose adaptability, are also identified in the paper. In emerging arche of Agentic AI, dynamic decision making is addressed by methodological needs in industries.

**KEYWORDS:** AI, Agentic, Disaster, Autonomous.

## I. INTRODUCTION

Agentic AI represents a step change into artificial intelligence, one that allows systems to learn environments dynamically, set goals, and take actions. Agentic AI motion beyond traditional static generative models through open learning dynamics combined with ethical and adaptive frameworks. In this paper, we explore its architecture, the resulting ethical implications, its applications in many industries, and advancements that may be necessary in the future before the field of autonomous vehicles, personalized services, and healthcare are completely revolutionized.

## II. AGENTIC AI

With the rise of Agentic AI, a new paradigm in artificial intelligence is entering; whereas previous Generative AI models focused on breadth and loosely defined goal function, Agentic AI intertwines these concepts with autonomy, adaptability and goal-driven behaviour. While the responses provided by traditional AI systems are based on pre-defined inputs, Agentic AI has the unique capability to decide goals 'outside' an input space, infer ambiguous contexts and grow from self-directed learning. In this section we define what Agentic AI is, what its key attributes are and how it differs from existing Generative AI models.

### Definition

Beyond the algorithms that perform decisions, agentic AI takes a step forward on the road to artificial intelligence as a system capable of making autonomous decisions [1]. These systems operate without continuous human intervention, and hence require these systems to be autonomous to make decisions on their own and take actions on their own. In other words, an autonomous supply chain optimization system running Agentic AI could take live data, make predictions about disruptions and mitigate those, without human confirmation.

One other characteristic defining Agentic AI is goal driven behaviour. Agentic AI is unlike traditional AI, which requires a specific prompt or a query for working with its objectives; instead, Agentic AI can resolve its objectives using contextual understanding. In one example, an AI agent programmed for disaster response might quickly rank orders of crises according to both the level of criticality (severity) and the urgency (immediacy) of each, with this ranking changing with new data that emerges [2].

Agentic AI is adapting able enough to circumvent the complex and changing environments. These systems get better at doing something through reinforcement learning or meta learning after it experiences new things. The ability to adapt to this in domains like the personalized healthcare domain where you have to adapt to patients changing needs and pressures.

The systems of these loops and learning can continue their decision-making processes getting better more effective, and reliable as time goes. An example is an autonomous vehicle outfitted with Agentic AI that has the ability to not only learn how to optimize routes, but learn to adapt the vehicle’s driving style based on traffic patterns and other weather conditions while still maintaining a safer, more efficient travel experience.

Unlike traditional AI, Agentic AI is more than the static, reactive nature of traditional AI, and features autonomy, goal driven behaviour, adaptability, and self-evolution [3]. These attributes have made this technology a game changer with wide potential applications in logistics and other fields basis individual needs.

Agentic AI and Generative AI are the more functional variants of Artificial Intelligence but there is a huge difference between both these two. However, it all comes down to how they make decisions, and how they interact with their environment.

Table 1 Difference between Agentic AI and Traditional GenAI models

| Aspect                  | Traditional Generative AI           | Agentic AI                                     |
|-------------------------|-------------------------------------|--|
| <b>Decision-Making</b>  | Reactive                            | Proactive                                      |
| <b>Autonomy</b>         | Limited                             | High   |
| <b>Learning</b>         | Pre-trained                         | Adaptive                                       |
| <b>Awareness</b>        | Minimal                             | High   |
| <b>Goal Orientation</b> | Defined by users during interaction | Self-directed                                  |
| <b>Examples</b>         | GPT-based systems, Chatbots         | Autonomous vehicles, disaster response systems |

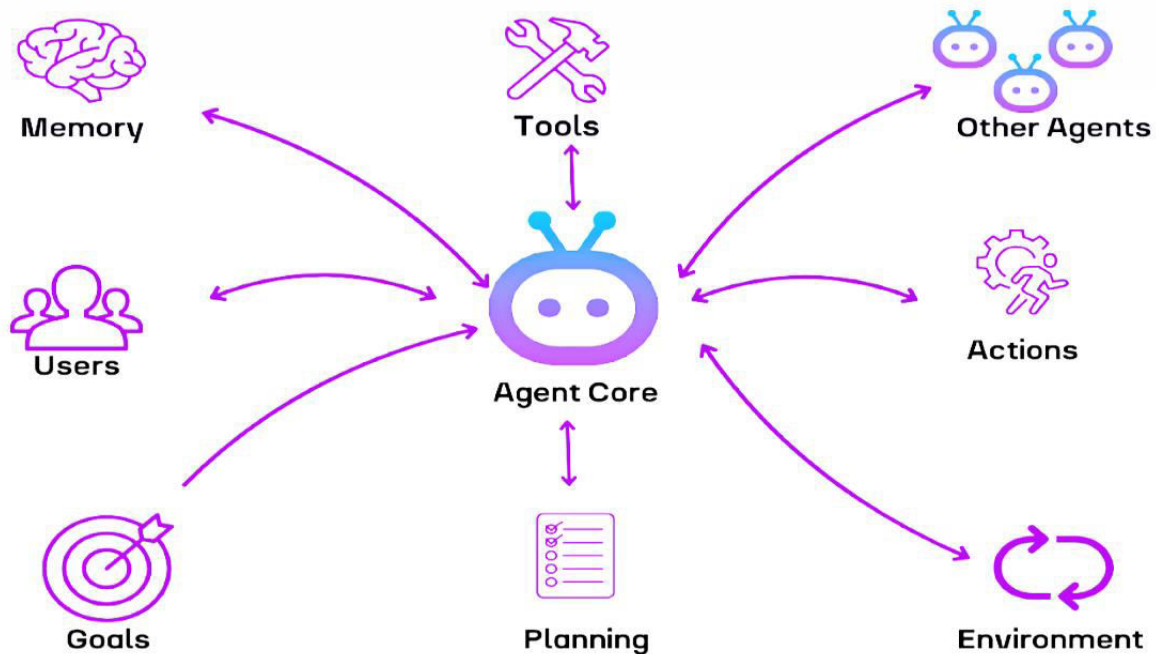


Fig. 1 Characteristics (Moveworks, 2024)

Generative AI models trained in the traditional form, like GPT-based systems, are good at generating human-like text and doing whatever no one has taught them to do. Firstly, however, the proposed AI has the inability to change dynamically or act independently, hallmarks of Agentic AI. For example, a GPT based chatbot can answer a customer query, but it cannot proactively see recurring issues or automatically solve them [4]. Instead, an Agentic AI would be able to take apart patterns of customer complaints, identify the most pressing issues and detect fixes for them, autonomously, a sophistication that goes way beyond generative AI.

When we begin to understand these differences, it is therefore obvious that Agentic AI is a paradigm shift in artificial intelligence, for adaptive, goal orientated decision making in complex domains has never before been possible.

### III. AGENTIC AI ARCHITECTURE

#### Core Components

**Modular Decision Engines:** The brain of any Agentic AI system, which turns on its own decisions engine, is a modular decision engine. The input represented, which is processed by this engine, with options and to make a decision upon given objective or dynamically set goal [5]. That decision engine is modular, which means it can be customized for specific tasks or domains and easily merged with other functionality at will. For example, we can have one module for inventory forecast and other for route optimization in a supply chain optimization problem statement.

**Context-Aware Feedback Loops:** Context aware feedback loops are key to agentic AI being able to maintain situational awareness, and adapt to new conditions. These loops both monitor the system's performance as well as the external environment, providing real time feedback to the decision engine [6]. For instance, an Agentic AI equipped autonomous drone could change its flight path based on sensor data detecting static or moving weather changes, or obstacles. This mitigates the system's delving into inappropriate course of actions in unpredictable environments. Learning also depends on feedback loops; the system knows how to refine its strategies as a function of past experiences.

**Adaptive Learning Mechanisms:** Agentic AI learns and evolves, which it does, with adaptive learning mechanisms. The system uses reinforcement learning (RL) to learn from trial and error, and meta learning to learn how to generalize across tasks [7]. As an example, a manufacturing collaborative robot would adapt its assembly process based on feedback from live interactions with human workers and changing production requirements through adaptive learning. These components drive a powerful, agentic architecture that equips Agentic AI systems to function independently, adapt to changes in context, and make decisions that optimize in the present (and future).

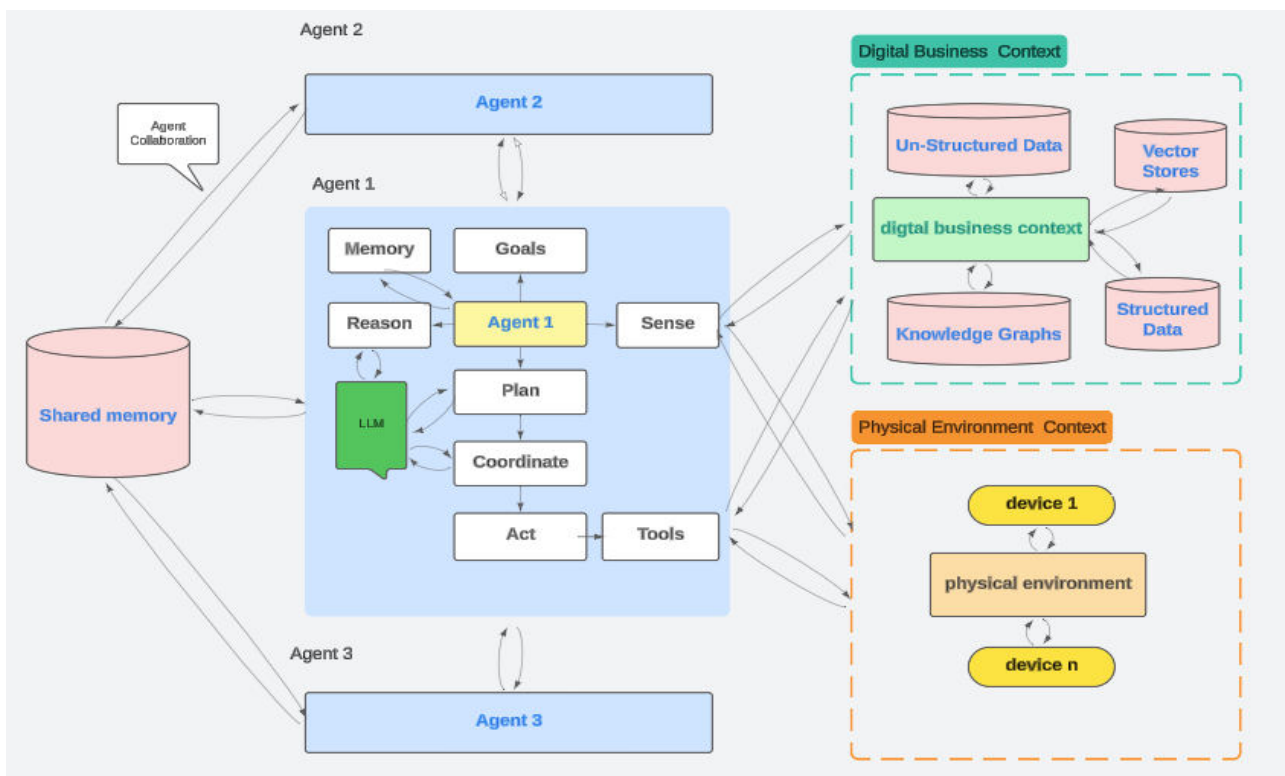


Fig. 2 Working flowchart (Medium, 2024)

### **Advanced Techniques**

Important role is played by advanced techniques for enhancement of the autonomy and effectiveness of Agentic AI systems. These systems achieve a previously unattained level of intelligence by integrating reinforcement learning, meta learning and dynamic goal setting.

Autonomous behaviour is an enabling aspect of Agentic AI utilizing reinforcement learning. But, in RL, an agent behaves by interacting with its environment and gets back either reward or penalty. The work of the system is to find optimal strategies to accomplish desired goals through the trial-and-error process [8]. A simple example would be if we were in a disaster response scenario, then an Agentic AI system would be able to use RL to decide how to allocate those resources, things like deployment of medical supplies to the areas that need it the most.

RL normally works on one deterministic task at a time, whereas meta learning is known as “learning to learn”, and combines with RL to let the system to generalize and adapt quickly to new task. By training such algorithms the system learns to infer patterns and take advantage of prior knowledge towards new situations and where fewer training examples are available, the learning time is often reduced. To illustrate, a meta learned healthcare assistant could learn personalized recommendations as a function of an individual’s specific medical history, as well as changing health conditions.

Dynamic goals are, however, a critical aspect of Agentic AI, and by this, we mean that it is able to create and execute goals via generative structures during the process of dynamic goal setting [9]. Agentic AI systems are different in that unlike normal AI systems, its goal is dependent on what are Ambient goals which not only changes from time to time but also changes based on the environment. This capability is realized through hierarchical decision-making frameworks that sort tasks and assign resources [10]. In a collaborative robotics application, an AI agent can then shift its focus from assembling components to quality inspection, if for instance a defect appears during production.

The system has dynamic decision pathways which permit them to evaluate several different courses of action and picked outcome that fits alongside what they’re aiming for. It is real time trade off analysis, so system balances efficiency on the one hand with safety on the other. Uncertainty is modelled with techniques such as probabilistic reasoning and Bayesian networks, and decision making is optimized in complex environments.

With the use of these advanced techniques Agentic AI systems achieve a level of autonomy and adaptability enabling them to excel at real world challenges.

### **Case Study**

The most compelling example of Agentic AI is real time decision making in disaster response. When disasters like earthquakes, hurricanes and wildfires happen — fast, coordinated action is needed to save lives and property. Such challenges are intrinsically suited to the processing of huge amounts of data, changeable conditions, and autonomous decision making afforded to Agentic AI systems.

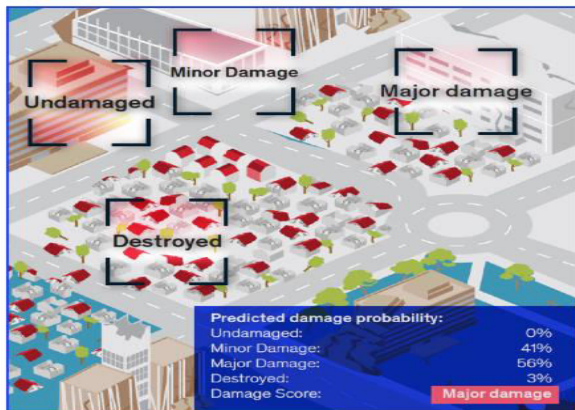
An Agentic AI would be nice as the centre of a disaster response system, which would coordinate across several agencies and resources. It could have integrated data from satellites imagery, weather reports as well as social media feeds and generate a global situational awareness [11]. With this data the AI has been able to find the places that are most affected by the disaster and made the rescues and relief work more prioritised.

In a hurricane system may have drones assigned to deliver medical supplies to far flung places and human responders directed to the most populated areas. Feedback loops would be context aware, so that the system reacts to new information presented, for instance, weather changes or secondary hazards appear.

# AI for Disaster Resilience

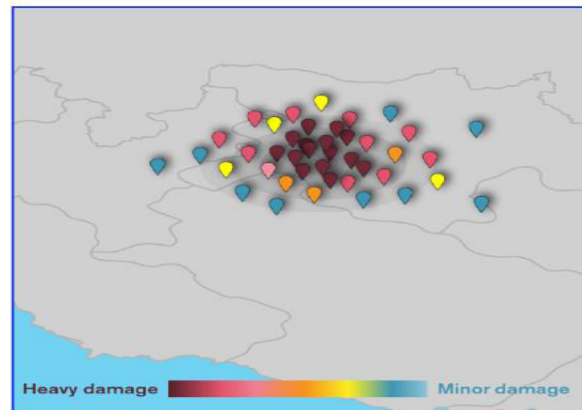
**Example of how AI can improve disaster resilience efforts:** Identifying damage and rebuilding after a disaster can take months of manual effort, leaving affected people vulnerable for a long time. AI can assess damage and help workers deliver aid much faster, improving recovery and shortening the time that affected people stay without resources

Predicting and classifying damage



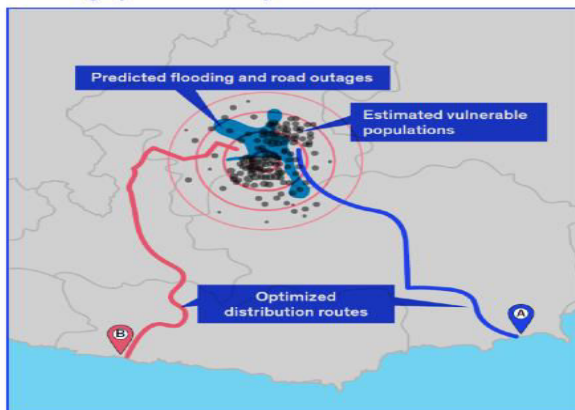
AI model can use satellite and other data to predict areas at risk

Geotagging damage for relief workers



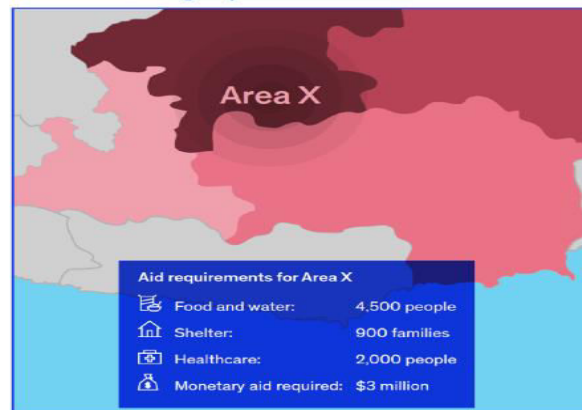
Damaged buildings and routes can be geo-tagged to help relief workers identify vulnerable areas and allocate resources optimally for faster response and recovery

Planning optimal delivery routes



AI can provide optimal route planning based on the damage assessment maps for faster aid delivery in post-disaster areas

Estimate funding requirements



Faster damage assessments can help governments and funders understand and provide necessary resources faster

Fig. 3 AI analysis of disaster management (The World Economic Forum, 2020)

## IV. ETHICS AND SAFETY

Especially as Agentic AI becomes more autonomous in high stake environments, the necessity to ensure the correct safe and ethical decisions is extremely important. One way to direct AI systems to behave as in alignment with human values — and often societal norms — and domain specific principles is through embedding value alignment frameworks.

Consequently, the Agentic AI in healthcare may be challenged along ethical dimensions of such as resource allocation and patient care priorities, which will ask Agentic AI to make trade-offs among fairness and urgency. Ethical dilemmas

arising in autonomous vehicles such as whether to choose passenger or pedestrian safety point to the difficulty of programming morally driven decision making into AI [12]. Careful system design, and ongoing stakeholder input, is necessary to mitigate against conflict that arises in these scenarios.

It is equally important to design on fail-safes and safety mechanisms in such a way so that autonomous systems operable responsibly. The techniques of the interpretability, transparency and explainability used for enabling the AI enable humans to reduce the barrier of access and understanding to these decision-making processes.

The dishonest use of XAI in financial fraud detection allows analysts to find why specific transactions got detected, establishing trust and accountability. The redundant decision-validation systems add additional layers of safety helping to prevent critical errors. Algorithmic biases, the absence of regulatory oversight and accountability issues have not gone away.

### V.APPLICATIONS

#### Autonomous Vehicles

With the advent of agentic AI, we open the door to truly transforming possibilities across more dynamically and contextually aware systems. Its most important application is in the field of autonomous vehicles, where real time decision making is paramount for dealing with an uncertain environment. Given the ever-changing nature of inputs from multiple sensors, prediction of the actions of other drivers or pedestrians, while maintaining safety and efficiency is essential for these systems [13]. Agentic AI in autonomous vehicles is different than traditional programmed systems in that they can dynamically adjust to novel situations—re-routing because of adverse weather or a reaction to an unexpected road hazard.

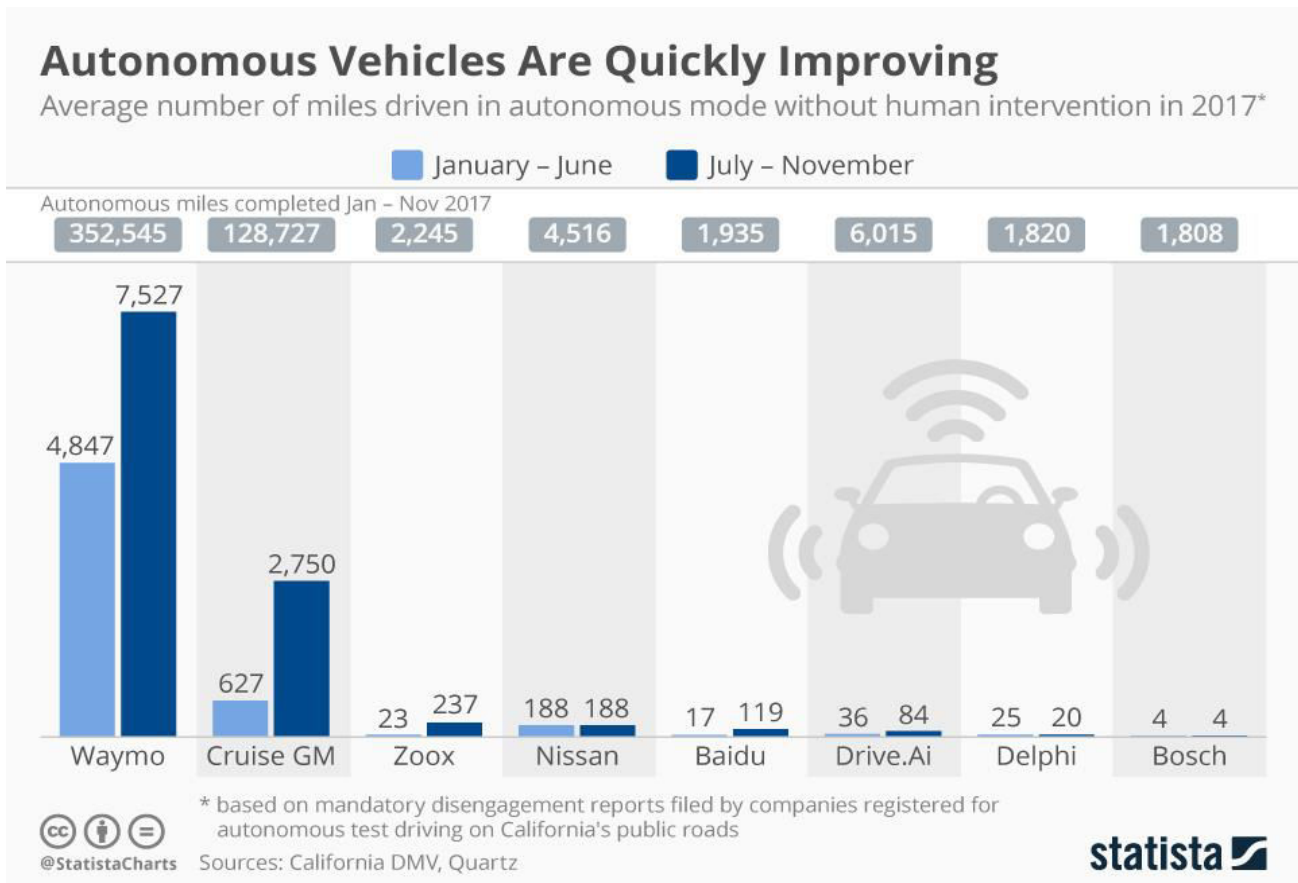


Fig. 4 Autonomous Vehicles Growth (Statista, 2018)

### Robots

The other significant use case is in collaborative robots especially in manufacturing or healthcare. Robots such as these are able to autonomously adapt to the tasks, they perform in a way that is compatible with the efficiency demands of production, working alongside humans, and do so in a way that is compatible with production efficiency. In healthcare, Agentic AI Robots can help with surgery by working on analysing real time patient data to execute surgical action to achieve precision and safety.

### Personalised Services

Agentic AI benefits greatly to real-world services such as personalization, e.g., virtual assistants or recommendation engines. These systems can analyse a user's behaviour, predict what their preferences are, and then change the interactions in real time [14]. An example of this is an Agentic AI autonomous travel assistant that proposed an itinerary for a vacation for the user, matching the budget the user has, his preferences and his time constraints, showcasing the kind of revolution the Agentic AI could bring to customer experience across different domains.

### Challenges

Agentic AI systems have great potential, but building them at scale presents many scaling and computational efficiency issues. To enable Agentic AI, there is the requirement for massive computational resources to rapidly parse complex data streams, learn from feedback, and make real time decisions—prohibitive for many industries [15]. Moreover, these systems have to strike a balance between responsiveness and energy constraints as well as hardware limitation in cases of the energy constraints and resource constraints, such as edge devices or autonomous drones. Interpretability is also a major barrier, as it affects the trust building very directly.

Unlike traditional systems that have simple straight path decisions, Agentic AI runs on complex models that often have limited transparency and users are unable to understand or validate its decisions. For instance, autonomous vehicle where likeability of anyone being able to explain why a particular action has been taken would begin to erode that trust in cases where there is an accident or a near miss.

## VI. FUTURE DIRECTIONS

### Research Gaps

We review the progress that has been made in Agentic AI thus far, but also identify many research gaps, in particular in order to achieve advanced context awareness and meta cognition. Current systems can handle structured inputs, but still have difficulty with unstructured, ambiguous data as we see in real world scenarios. For example, disaster response agent that works on its own could get stuck without the ability to make decisions on the lack of information from many resources: a sensor network, social media feed, human report, etc.

There is a critical gap in improving over the long term's learning adaptability. Reinforcement learning and the like are also dominant for most Agentic AI systems, which aren't necessarily well suited to decisions with cumulative, long term necessary decision outcomes. To tackle this, researchers must develop advanced meta learning techniques such that systems can learn and adapt to its strategies spanning multiple lifecycles.

### Opportunities

The cognitive neuroscience could be partnered with to discover how human like decision making as well as emotional intelligence can replicate in AI Systems. Knowing well how humans deal with complex data and intuitive decision taking, they could design AI agents capable of more natural and meaningful human interactions.



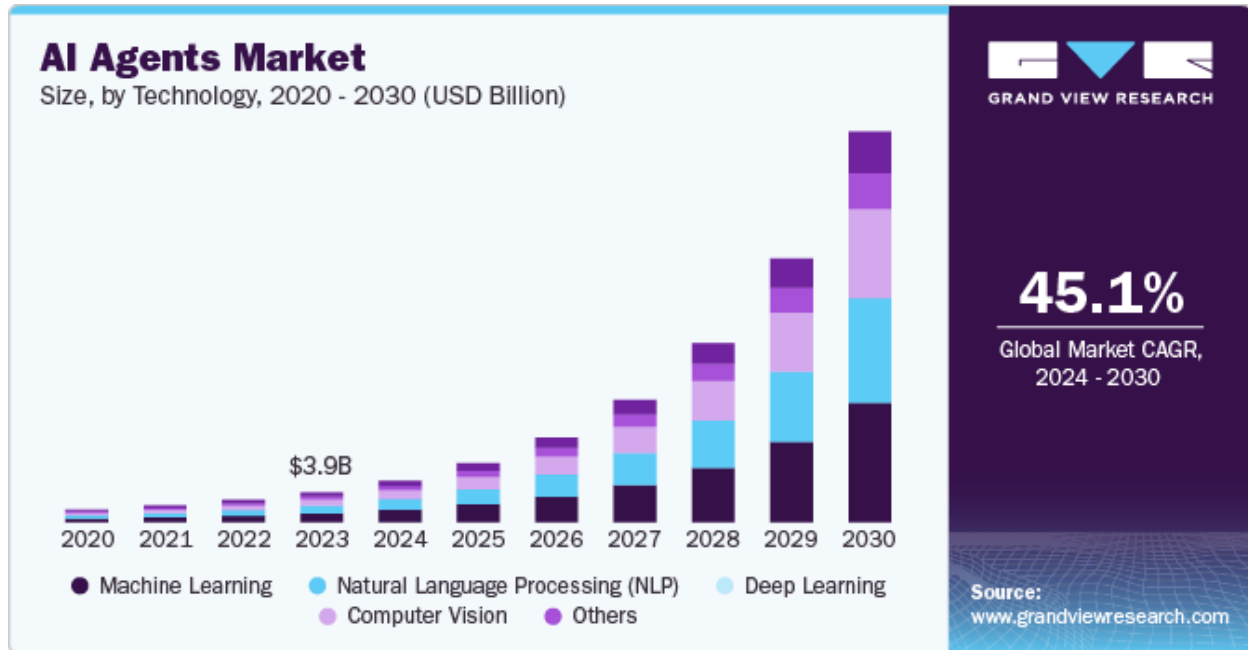


Fig. 5 Global Market (Grand View Research, 2023)

Such enhancement can be very valuable for using applications in areas such as healthcare, education, and customer service, where trust, but also empathy, is essential. A second area that seems promising is to build general-purpose Agentic AI capable of adapting in most problems. These systems would be able to seamlessly shift from using supply chain logistics to managing urban traffic flows, to offering personalized learning experiences. These degrees of versatility would require stages in transfer learning and generalization for systems to utilize knowledge learnt in one setting to another.

## VII.CONCLUSION

Agentic AI is the next frontier of artificial intelligence, systems that have external reactive powers to make adaptive autonomous decisions in dynamic environments. This paradigm addresses scalability, interpretability and compliance problems to change industries like healthcare to disaster response.

Agentic AI must work in a dynamic and uncertain environment which is an open challenge to its reliability. To be robust and avoid catastrophic failure the systems must be robust enough to absorb unexpected inputs or edge cases. Therefore, we need to enhance interpretability of models, enhance the computational efficiency, and put into place such regulatory framework, which spurs safe deployments of models. We need to resolve these issues, if not, the Agentic AI will have widespread adoption hurdles and will not be able to unleash its transformative power at such a scale.

## REFERENCES

- [1] Y. Shavit et al., "Practices for governing agentic AI systems," Research Paper, OpenAI, Dec. 2023. [Online]. Available: <https://cdn.openai.com/papers/practices-for-governing-agentic-ai-systems.pdf>
- [2] S. Sivakumar, "Agentic AI in predictive AIOps: Enhancing IT autonomy and performance," Int. J. Sci. Res. Manag. (IJSRM), vol. 12, no. 11, pp. 1631–1638, 2024. [Online]. Available: <https://doi.org/10.18535/ijrm/v12i11.ec01>
- [3] D. B. Acharya, K. Kuppan, and B. Divya, "Agentic AI: Autonomous intelligence for complex goals—A comprehensive survey," IEEE Access, 2025. [Online]. Available: 10.1109/ACCESS.2025.3532853

- [4] A. Paul, C. L. Yu, E. A. Susanto, N. W. L. Lau, and G. I. Meadows, "Agentpeertalk: Empowering students through agentic-ai-driven discernment of bullying and joking in peer interactions in schools," arXiv preprint, arXiv:2408.01459, 2024. [Online]. Available: <https://doi.org/10.48550/arXiv.2408.01459>
- [5] A. Chan et al., "Harms from increasingly agentic algorithmic systems," in Proc. 2023 ACM Conf. Fairness, Accountability, Transparency, Jun. 2023, pp. 651–666. [Online]. Available: <https://doi.org/10.1145/3593013.3594033>
- [6] H. Clatterbuck, C. Castro, and A. M. Morán, "Risk alignment in agentic AI systems," arXiv preprint, arXiv:2410.01927, 2024. [Online]. Available: <https://doi.org/10.48550/arXiv.2410.01927>
- [7] J. A. Strunk, L. Banh, A. Nissen, G. Strobel, and S. Smolnik, "To delegate or not to delegate? Factors influencing human-agentic IS interaction," 2024. [Online]. Available: [https://aisel.aisnet.org/icis2024/lit\\_review/lit\\_review/2](https://aisel.aisnet.org/icis2024/lit_review/lit_review/2)
- [8] B. Svensson and C. Keller, "Agentic relationship dynamics in human-AI collaboration: A study of interactions with GPT-based agentic IS artifacts," 2024. [Online]. Available: <https://hdl.handle.net/10125/107261>
- [9] N. Watson et al., "Guidelines for agentic AI safety Volume 1: Agentic AI safety experts focus group-Sept. 2024," 2024. [Online]. Available: <https://www.linkedin.com/groups/12966081/>
- [10] D. Ogbu, "Agentic AI in computer vision domain—Recent advances and prospects," 2023. [Online]. Available: [https://www.researchgate.net/profile/Daniel-Ogbu/publication/386292786\\_Agentic\\_AI\\_in\\_Computer\\_Vision\\_Domain\\_-\\_Recent\\_Advances\\_and\\_Prospects/links/674c6ec6a7fbc259f1a33618/Agentic-AI-in-Computer-Vision-Domain-Recent-Advances-and-Prospects.pdf](https://www.researchgate.net/profile/Daniel-Ogbu/publication/386292786_Agentic_AI_in_Computer_Vision_Domain_-_Recent_Advances_and_Prospects/links/674c6ec6a7fbc259f1a33618/Agentic-AI-in-Computer-Vision-Domain-Recent-Advances-and-Prospects.pdf)
- [11] L. Moradbakhti, S. Schreiberlmayr, and M. Mara, "Do men have no need for 'feminist' artificial intelligence? Agentic and gendered voice assistants in the light of basic psychological needs," *Front. Psychol.*, vol. 13, 2022. [Online]. Available: <https://doi.org/10.3389/fpsyg.2022.855091>
- [12] N. Kolt, "Governing AI agents," arXiv preprint, arXiv:2501.07913, 2025. [Online]. Available: <https://doi.org/10.48550/arXiv.2501.07913>
- [13] J. Carlsmith, "Is power-seeking AI an existential risk?" arXiv preprint, arXiv:2206.13353, 2022. [Online]. Available: <https://doi.org/10.48550/arXiv.2206.13353>
- [14] B. S. Vanneste and P. Puranam, "Artificial intelligence, trust, and perceptions of agency," *Acad. Manage. Rev.*, 2024. [Online]. Available: <https://doi.org/10.5465/amr.2022.0041>
- [15] A. Chan et al., "Visibility into AI agents," in Proc. 2024 ACM Conf. Fairness, Accountability, Transparency, Jun. 2024, pp. 958–973. [Online]. Available: <https://doi.org/10.1145/3630106.3658948>



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details