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ARTIFICIAL INTELLIGENCE TRENDS IN RECENT YEARS: A RESEARCH OVERVIEW

Toshiba Shukla, Aryan
[1]*Educator on Unacademy*
[2]*Assistant Professor, Technology Education and Research Integrated Institution*

ABSTRACT

This research paper provides a comprehensive overview of major trends in artificial intelligence (AI) in recent years (roughly 2022–2025). We examine advances in technology (model scaling, generative AI, democratization of AI), shifts in application domains (industry adoption, health, edge/IoT), research and innovation metrics (publications, patents, hardware), and societal, ethical, regulatory implications (energy footprint, bias, regulation, geopolitics). The paper concludes with discussion of key challenges and future directions for AI.

KEYWORDS: *Artificial Intelligence, Generative AI, AI Democratization, AI Research Trends, AI Ethics, AI Hardware, Edge AI.*

1. INTRODUCTION

Artificial intelligence (AI) has moved rapidly from research labs into widespread deployment across industries, businesses, and daily life. Over the past few years in particular—with the rise of large language models (LLMs), generative AI, and improvements in hardware and infrastructure—the pace of innovation and adoption has accelerated. This paper aims to chart and synthesise the key trends visible in AI's evolution over the recent period, grounded in empirical data (publications, patents, hardware, applications) and informed by industry analyses.

The contributions of this paper are:

1. A structured presentation of major technological and market trends in AI.
2. A data-driven account of research and innovation dynamics (publications, patents, hardware).
3. A mapping of application domains and societal/ethical/regulatory issues.
4. Identification of the challenges and potential future directions for the field.

2. TECHNOLOGICAL AND MARKET TRENDS IN AI

2.1 Model Scaling, Cost Decline, and Generative AI

One of the most salient trends is the rapid increase in model scale (parameters, compute, dataset size) and simultaneously the dramatic decline in cost of inference and deployment of these models. For example, the Artificial Intelligence Index Report 2025 states that the cost of querying a model achieving GPT-3.5 level performance dropped from USD $20/ million tokens in November 2022 to just USD $0.07/ million tokens by October 2024. hai.stanford.edu+2hai.stanford.edu+2

Generative AI—models capable of producing text, images, audio or video—is another major driver. These models enable new use-cases (content creation, synthetic data, personalization) and are reshaping how AI is applied. Cyber Nest+1

2.2 Democratization of AI: Low-Code/No-Code and Citizen Developers

A trend of growing significance is the democratization of AI: tools and platforms are lowering the barrier to entry for non-engineers to build AI-enabled apps. Low-code / no-code platforms allow "citizen developers" to create AI workflows without deep programming expertise. For example, one report indicates that by 2025 the low-code/no-code market may hit US$32 billion, with many users lacking formal coding background. milaohaath.com

2.3 Edge, IoT and Distributed AI

AI is increasingly moving toward edge devices, IoT sensors, and embedded systems rather than being confined to large data centres. This trend is driven by latency, privacy, connectivity and cost concerns. For instance, one source projects the AI in edge devices market to reach US$36.6 billion in 2025. Technource

2.4 Hardware, Efficiency, and Energy Considerations

With model sizes increasing and compute demands exploding, hardware and energy efficiency have become critical. The AI Index report notes that ML hardware performance (16-bit floating-point operations) has grown ~43% annually, doubling roughly every 1.9 years, price performance dropping ~30% per year, and energy efficiency improving ~40% annually. hai.stanford.edu+1

However, the energy and carbon footprint of training large AI models is also rising. For example: Training the GPT-4 model in 2023 emitted ~5,184 tons of CO_2; a later model, the Llama 3.1 405B (2024) emitted ~8,930 tons. hai.stanford.edu

2.5 Research, Publications, and Patents

The amount of AI research output has surged. Between 2013 and 2023 the number of AI-related papers rose from ~102,000 to over 242,000; the proportion of AI papers in computer science rose from 21.6% to 41.8%. Efficient Coder+1

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Patent filings are also increasing rapidly: from ~3,833 AI patents in 2010 to ~122,511 in 2023, a rise of ~29.6% in a single recent year. China accounted for ~69.7% of AI patents in 2023. hai.stanford.edu

3. APPLICATION DOMAINS & ADOPTION

3.1 Industry and Enterprise Adoption

AI uptake across enterprises has accelerated. For instance, according to some analyses, the adoption of generative AI in enterprises doubled year-over-year since 2023. Technource+1
AI is being deployed in automation (robotics, manufacturing), logistics, predictive maintenance, customer service (chatbots), personalization, healthcare, finance, and more. aitimejournal.com+1

3.2 Healthcare & Medicine

AI's role in healthcare has grown significantly. A bibliometric study covering 2000–2024 found over 22,000 research articles on AI/ML in health and medicine, with hotspots including Alzheimer's disease, Parkinson's disease, COVID-19, diabetes. The dominant research themes include "deep learning", "convolutional neural network", "classification". MDPI

3.3 Societal Use and Consumer Behavior

AI is increasingly used by consumers. For example, a survey found that more than one-third (35%) of Americans use AI to manage health and wellness (meal planning, emotional support, fact-checking health info). New York Post
In educational contexts, in India (Delhi) higher-education students showed rising use of AI tools for academic writing, research, learning complex subjects. The Economic Times

3.4 Geopolitical and Market Impacts

AI development and deployment have strong geopolitical dimensions: countries compete in model development, hardware supply chains, talent, and standards. The 2024 and 2025 index reports emphasise the role of the U.S., China, Europe in research, patents and model creation. hai.stanford.edu+1

4. SOCIETAL, ETHICAL & REGULATORY DIMENSIONS

4.1 Bias, Hallucinations, Misinformation and Safety

With increasingly capable AI models, concerns around bias, "hallucinations" (false outputs), deepfakes, misuse (cyberattacks, biothreats) are growing. khanglobalstudies.com

4.2 Energy & Environmental Impact

As noted earlier, training large models consumes large amounts of energy and results in non-trivial carbon emissions. This raises sustainability concerns for AI at scale.

4.3 Regulatory, Ethical & Governance Issues

Governments and organisations are increasingly focusing on "responsible AI" frameworks—transparency, fairness, auditability, risk-assessment. One source suggests that 72% of Fortune 500 CEOs regard responsible AI frameworks as a top priority. Technource+1

Also the interplay between regulation and competition is highlighted: rapid commercialisation risks out-pacing regulatory oversight or focusing on competition over safety. The Guardian

4.4 Democratization vs. Centralisation

While AI is becoming more accessible (citizen development, low-code), there remains tension between large-scale models developed by big players (with large compute budgets) and more distributed, embedded, localised AI. The dominance of certain nations or companies in model creation (e.g., U.S. vs China) may shape global power-balance.

5. CHALLENGES AND FUTURE DIRECTIONS

5.1 Technical Challenges

- Model interpretability and transparency.
- Reducing hallucinations and ensuring trustworthiness.
- Improving data efficiency (fewer data, less compute) and moving beyond brute-force scaling.
- Edge/embedded AI: making models efficient for constrained devices.
- Sustainability: reducing carbon footprint, increasing hardware efficiency.

5.2 Adoption and Integration Challenges

- Skills gap and talent shortage.
- Integration of AI into legacy systems and workflows.
- Data privacy, security, regulation.
- Ensuring equitable access and avoiding exacerbation of digital divides.

5.3 Ethical, Societal & Governance Challenges

- Managing bias, fairness, and inclusivity in AI systems.
- Regulatory lag and global coordination on AI governance.
- Ensuring safety and preventing misuse (dual use, adversarial attack, deepfakes).
- Balancing innovation and competition with oversight and responsibility.

5.4 Future Directions

- More efficient, smaller, domain-specific models ("tiny AI", "on-device AI").
- Multimodal models (text, image, audio, video, sensor) and AI agents that act in environments.
- Synthetic data generation to overcome data scarcity/privacy issues.
- Human-AI collaboration: augmentation rather than replacement.
- AI for global development: affordability, accessibility, localised solutions, especially in emerging economies such as India.
- Sustainable compute architectures, novel hardware (neuromorphic, analog AI).
- Governance frameworks, international norms, AI ethics embedded in design.

6. CONCLUSION

In recent years, AI has transitioned from experimental to ubiquitous, with dramatic leaps in capability, cost-efficiency, and application breadth. The combined trends of model scaling, democratization, edge deployment, and increasing research

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output illustrate a dynamic and rapidly maturing field. Yet alongside the promise lie significant challenges—in governance, ethics, sustainability, integration and equity.

To harness AI's full potential while mitigating risks, stakeholders (researchers, industry, policymakers) must engage in collective, thoughtful action: building efficient and transparent models; embedding ethical considerations in design; and ensuring that AI serves broad societal goals rather than narrow commercial or geopolitical interests.

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