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Abstract: The democratization of artificial intelligence (AI) involves extending access to AI technologies beyond specialized technical experts to a broader spectrum of users and organizations. This paper provides an overview of AI's historical context and evolution, emphasizing the concept of AI democratization. Current trends shaping AI democratization are analyzed, highlighting key challenges and opportunities. The roles of pivotal stakeholders, including technology firms, educational entities, and governmental bodies, are examined in facilitating widespread AI adoption. A comprehensive framework elucidates the components, drivers, challenges, and strategies crucial to AI democratization. This framework is subsequently applied in the context of scenario analyses, offering insights into potential outcomes and implications. The paper concludes with recommendations for future research directions and strategic actions to foster responsible and inclusive AI development globally.

Keywords: AI democratization; theoretical framework; scenario analysis



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1. Introduction

Artificial intelligence has rapidly evolved from a niche academic discipline to a transformative technology with wide-reaching applications. As AI becomes more integrated into various sectors, there is a growing movement to democratize AI, ensuring that its benefits are not limited to a select few but are distributed across society. Democratization of AI can be described as a reality where “every person and every organization” has access to technology powered by AI [1,2], or as “to the demand that AI be made widely available or useable or that individuals should be empowered to develop or use AI. Training data should be accessible, AI technologies should be affordable, and their use should be encouraged” [3]. Other authors describe the democratization of AI as providing widespread access to open data and AI models for non-technical individuals. This access allows them to effectively use AI models in specific contexts without needing deep technical expertise. In this context, some questions are raised by previous studies: Are big companies the adequate players to manage open data and deploy AI models for governing such ecosystems [4]? Are there ethical, societal, and safety challenges being addressed when we use open data and open-source models [5]? Are the main stakeholders being taken into consideration [6]?

We live in a context of massification of AI usage, particularly now. Every company, public organization, and nation can easily use Generative AI models to pursue its objectives. As such, this paper aims to provide a comprehensive overview of AI democratization, highlighting its significant key dimensions that are part of a proposed theoretical framework for democratizing AI and exploring the main application usage contexts. This paper brings two contributions from theory. First, it identifies the main dimensions upon which the democratization of AI can be studied and identifies the main domains that each dimension

attains when studying the democratization of AI, serving as a solid base to cover the principal aspects this topic entails. Future studies may use this framework to organize in-depth studies on each of the dimensions of democratization of AI.

This study is organized into eight sections. The paper presents a comprehensive overview of the democratization of artificial intelligence (AI), which makes AI technologies accessible to a broader range of people and organizations. It discusses the historical context of AI, current trends (Section 2), key stakeholders (Section 3), ethical considerations, challenges, and opportunities (Section 4). The paper proposes a theoretical framework (Section 5) for democratizing AI, highlighting its significance, key drivers, and general challenges. The framework includes key components such as accessibility, affordability, usability, ethical and regulatory considerations, and drivers, challenges, and strategies for effective democratization. This is followed by the exposition of possible scenarios of AI democratization (Section 6), and discussion (Section 7), finishing with conclusions (Section 8).

2. Context and Current Trends in AI Democratization

The origins of AI date back to the mid-20th century, with pioneering work by researchers like Alan Turing [7] and John McCarthy [8]. Initially, AI research was confined to academic institutions and characterized by limited computational resources and theoretical exploration. The advent of micro-computers in the 1980s [9] led to the democratization of computing. Significant advancements in machine learning and the availability of big data in the late 20th and early 21st centuries marked a shift in AI development. These advancements enabled the creation of more sophisticated algorithms and practical applications, sparking increased interest from industry and governments.

The open-source movement has played a crucial role in AI democratization [10]. Platforms like TensorFlow [11], PyTorch [12], and scikit-learn [13] have made powerful AI tools available to anyone with an internet connection, fostering innovation and collaboration globally.

Current trends in AI democratization [14–16] unveil considerable topics that must be addressed. Some belong to the application fields of AI, others to the fastest technological evolution, and the challenges that need to be addressed when AI is adopted in the various fields of society and economy [17]. The current AI democratization trends may be considered at the following levels: governance and decision-making, accessibility and affordability, distributed learning systems, social and ethical considerations, and public data trust.

Democratization must include governance reforms to ensure public deliberation and stakeholder involvement in AI research and development (R&D). Barriers include deterministic AI development narratives, opaque decision-making processes, and the dominance of technical experts and business executives [18]. Effective democratization requires a framework for the democratic governance of AI [19]. Democratizing AI includes making technologies accessible and affordable, ensuring portability, explainability, credibility, and fairness. These aspects require advancements in science, technology, and policy [20]. Large-scale distributed AI systems, characterized by self-organizing, hierarchical structures, can contribute to democratizing AI by enabling collaborative learning across various devices and environments. These systems aim to surpass traditional federated learning by enhancing generalization and specialization capabilities [21]. Addressing social and ethical challenges is crucial for democratizing AI. This includes ensuring AI transparency, privacy, and fairness, particularly in data-centric sectors like energy management. A framework for AI and data democratization can help mitigate biases and enhance decision-making processes [22]. Establishing public data trusts to control training data for AI models can ensure that the economic value generated by AI is redistributed to address its negative externalities. This approach emphasizes collective decision-making and the regulation of data use [23].

Other AI democratization trends, such as cloud-based AI services, educational initiatives, and AI in the public sector, may be considered. Cloud computing has been instrumental in democratizing AI by providing scalable resources that can be accessed

on demand. Amazon Web Services (AWS), Google Cloud, and Microsoft Azure offer user-friendly and cost-effective AI and machine learning tools, enabling small businesses and individual developers to leverage AI technologies [24–27]. Regarding the recent trend of educational institutions, universities and massive open online courses (MOOCs) on platforms increasingly offer courses and certifications in AI and machine learning. Programs from organizations such as Coursera, edX, and Khan Academy [28–30] have made high-quality AI education accessible to a global audience worldwide, empowering a new generation of AI practitioners and users. Governments worldwide recognize AI's potential to drive economic growth and improve public services [31,32]. Public and governmental initiatives to protect citizens' privacy, data governance, and public policies that are applied at a country level or at a supranational level, such as the European Union's AI strategy [33] and the United States' AI for the American People [34] aim to promote AI research, education, and ethical guidelines, ensuring that AI benefits are widely shared and citizen rights are preserved.

3. Key Stakeholders in AI Democratization

AI democratization entails the aforementioned trends, although it also involves a set of stakeholders who play crucial roles in shaping the accessibility, fairness, and ethical standards of AI technologies and end users' AI technology usage. These main stakeholders include technology companies, educational institutions, governments and regulatory bodies, non-profit organizations and civil society, users, small and medium enterprises (SMEs), community groups, and advocacy organizations. Technological giant companies like Google, Microsoft, and IBM are pivotal in AI democratization efforts. By open-sourcing AI models and investing in educational resources, these companies reduce barriers to AI adoption and foster a more inclusive AI ecosystem by providing free accounts to any user who wants to use their AI models [35–37]. Their initiatives not only democratize access to AI tools across industries but also drive productivity and innovation and provide access to all individuals in a freemium business model. Other key stakeholders that play an important role in democratizing AI are universities and research institutions, being fundamental in advancing AI knowledge and preparing the next generation of AI experts as motors to conduct research in AI, as well as providing the general skills for ethical usage of the AI technology [38,39]. Collaborations between academia and industry can be essential for translating theoretical AI advancements into practical applications. These partnerships can ensure that AI education evolves alongside technological developments, equipping students with the skills needed to navigate complex AI landscapes and providing designed life-long learning programs to industry.

Governments play a critical role in AI democratization by shaping policies and regulations that promote the equitable distribution of AI benefits [33,34]. This includes funding AI research initiatives, supporting educational programs, and establishing ethical guidelines to address bias and privacy concerns. Regulatory bodies ensure that AI technologies are deployed responsibly and ethically, safeguarding societal interests while fostering innovation.

Non-profit organizations and civil society groups are stakeholders that advocate for ethical AI practices and promote transparency in AI development and deployment [40,41]. They engage in public discourse, raise awareness about AI's societal implications, and push for policies prioritizing human welfare and rights. These organizations ensure that AI technologies serve the public good and mitigate potential risks. Users are essential stakeholders in AI democratization, representing individuals and organizations interacting with AI technologies. Their feedback, preferences, and concerns shape the development and deployment of AI systems. User-centric design principles ensure that AI technologies meet usability standards, address user needs, and respect user privacy and security concerns. Local community groups and advocacy organizations represent diverse interests and voices in AI democratization efforts. They advocate for inclusive AI policies, address digital divides, and empower marginalized communities to participate in and benefit from

AI advancements [42]. Their grassroots initiatives promote equity and social justice in AI development and deployment and in science evolution [43].

SMEs play a vital role in AI democratization by leveraging AI technologies to innovate and compete in the global market. Accessible AI tools and resources enable SMEs to enhance productivity, optimize operations, and develop customized solutions tailored to business needs. Their involvement fosters economic growth and diversity in AI applications across various sectors [44,45]. By recognizing and engaging with these diverse stakeholders, AI democratization can be guided by inclusivity, transparency, and societal benefit, ensuring that AI technologies serve the needs and interests of all stakeholders involved, including users.

4. Ethical Considerations: Challenges and Opportunities

The literature proposes the discussion of ethical challenges when developing and using AI technology. Floridi and Cowls [46] proposed a unified framework of principles for ethical AI, advocating transparency, fairness, and accountability in AI development and deployment. This framework [46,47] identifies five overarching ethical principles: beneficence, nonmaleficence, autonomy, justice, and explicability. These principles provide ethical guidelines essential for ensuring AI technologies benefit society while minimizing potential harm. As for the main risks of AI usage, Floridi [48] mentions ethical principles of shopping, ethics bluewashing, ethics lobbying, dumping, and shirking. In the context of AI democratization, the ethical considerations that can be of most relevance are avoiding bias, ensuring fairness, complying with privacy and security, and accountability and transparency of AI technology.

One of the major challenges in AI democratization is ensuring that AI systems are fair and unbiased towards the datasets used to train AI models, which will definitely impact the final results. There is a risk that AI algorithms, if not properly designed and tested, can perpetuate existing biases and inequalities. Developing methodologies for detecting and mitigating bias in AI systems is crucial. As AI systems often rely on large amounts of personal data, ensuring privacy and security is a significant concern. Robust data protection measures and diverse and transparent data usage policies are essential to maintain public trust in AI technologies and to guarantee an unbiased outcome [48]. AI systems should be transparent and accountable, with clear explanations of how decisions are made [49]. This is particularly important in high-stakes areas such as healthcare, finance, and criminal justice, where AI decisions can profoundly impact individuals' lives.

Ethical considerations are not the only dimension to consider. Several challenges and opportunities address technical barriers, economic impacts, and global disparities. Despite advancements, there are still technical barriers to AI adoption, including the complexity of AI models and the need for significant computational resources. Simplifying AI tools and improving hardware efficiency are key areas of ongoing research. AI democratization can potentially drive economic growth and innovation, particularly for small businesses and startups. However, it also poses challenges such as job displacement and the need for workforce reskilling. Policies to support workers in transitioning to new roles are essential. While AI democratization can promote global innovation, there is a risk of intensifying disparities between developed and developing countries. International cooperation and support are necessary to ensure all regions benefit from AI advancements.

5. Proposing an AI Democratization Theoretical Framework

This section presents an AI democratization framework based on the literature review and analysis presented in Sections 2–4.

The framework is composed of four underlying components that must be present and considered in any scenario: accessibility (critical for democratic operationalization), affordability (ensuring generalized access to AI technologies), usability (determinant to AI adoption), and ethical regulations (support the ethical development and usage of AI technology). The framework comprises three main intertwined dimensions: drivers, challenges, and strategies. Each dimension is further divided into sub-components, as

shown in Figure 1. The dimensions represent the different aspects of AI democratization, such as access, participation, and governance. The drivers are the factors that enable or facilitate AI democratization, such as technological advancements, social movements, and ethical principles. The barriers are the challenges or obstacles that hinder or prevent AI democratization, such as technical complexity, data privacy, and ethical dilemmas. The impacts are the potential consequences or outcomes of AI democratization, both positive and negative, such as economic growth, innovation, job displacement, and global disparities. The framework identifies collaboration, education and training, and ethical practices as strategies that should be followed for AI Democratization. The framework aims to provide a comprehensive and holistic view of the phenomenon of AI democratization and to guide further research and practice in this field.

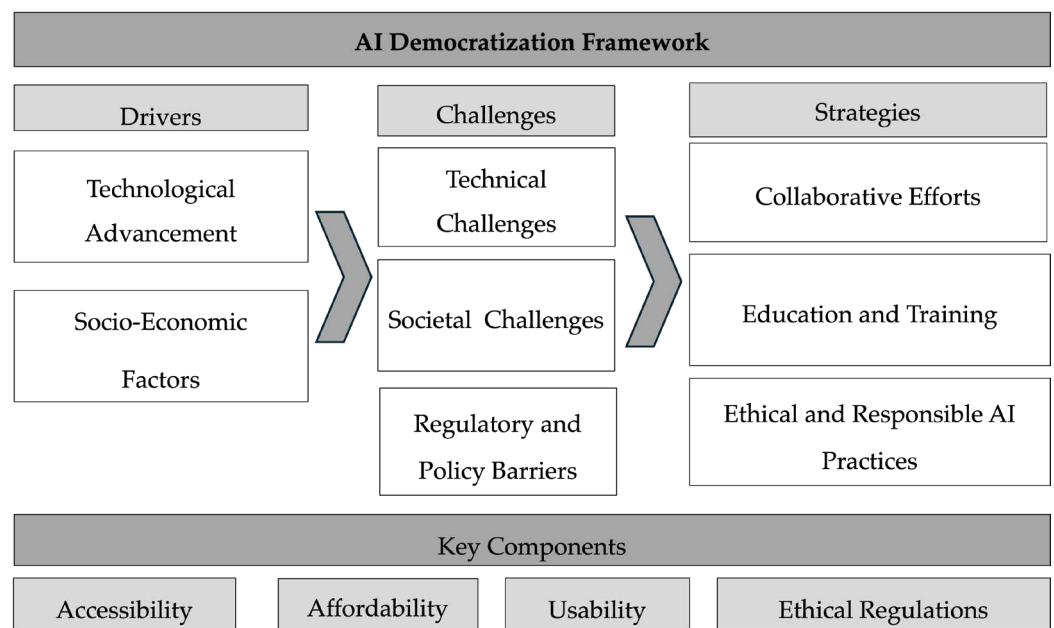


Figure 1. AI democratization framework.

The key components of AI democratization include accessibility, affordability, usability, and ethical and regulatory considerations (Table 1). Accessibility is divided into technological and educational aspects. Technological accessibility focuses on developing user-friendly AI tools, open-source AI platforms and libraries such as TensorFlow and PyTorch, and cloud-based AI services provided by companies like Google Cloud AI and AWS AI. Educational accessibility aims to make AI learning resources widely available through online courses and tutorials on platforms like Coursera and edX, university programs and certifications, as well as workshops, seminars, and hackathons.

Affordability is crucial for widespread AI adoption and is achieved through cost reduction and incentive structures. Cost reduction involves providing affordable computational resources, subscription models for AI services, and securing government and private funding for AI research and development. Incentive structures include grants and scholarships for AI education and public-private partnerships to subsidize AI projects.

Usability ensures that AI technologies are user-friendly and adaptable. This involves focusing on user experience design by creating intuitive interfaces for AI tools, simplifying programming languages and frameworks, and offering comprehensive documentation and support communities. Customization and flexibility are also essential, as they provide tools that can be tailored to specific needs and ensure interoperability with existing systems and data.

Table 1. Key components.

Key Components	Components	Description
Accessibility	Technological Accessibility	<ul style="list-style-type: none"> - Development of user-friendly AI tools - Open-source AI platforms and libraries (e.g., TensorFlow, PyTorch) - Cloud-based AI services (e.g., Google Cloud AI, AWS AI)
	Educational Accessibility	<ul style="list-style-type: none"> - Online courses and tutorials (e.g., Coursera, edX) - University programs and certifications in AI - Workshops, seminars, and hackathons
Affordability	Cost Reduction	<ul style="list-style-type: none"> - Affordable computational resources - Subscription models for AI services - Government and private funding for AI research and development
	Incentive Structures	<ul style="list-style-type: none"> - Grants and scholarships for AI education - Public-private partnerships to subsidize AI projects
Usability	User Experience Design	<ul style="list-style-type: none"> - Intuitive interfaces for AI tools - Simplified programming languages and frameworks - Comprehensive documentation and support communities
	Customization and Flexibility	<ul style="list-style-type: none"> - Tools that allow customization for specific needs - Interoperability with existing systems and data
Ethical and Regulatory Considerations	Ethical AI Practices	<ul style="list-style-type: none"> - Transparency in AI algorithms and data usage - Bias detection and mitigation - Privacy-preserving AI techniques
	Regulatory Frameworks	<ul style="list-style-type: none"> - Policies promoting responsible AI usage - Standards for data protection and AI safety - International cooperation on AI governance

Ethical and regulatory considerations are vital for responsible AI deployment. Ethical AI practices include transparency in AI algorithms and data usage, bias detection and mitigation, and privacy-preserving AI techniques. Regulatory frameworks involve developing policies that promote responsible AI usage, setting standards for data protection and AI safety, and fostering international cooperation on AI governance.

The drivers of AI democratization encompass technological advancements and socio-economic factors (Table 2). Technological advancements are fueled by innovations in AI research, including breakthroughs in machine learning, natural language processing, and computer vision, as well as the development of more efficient and scalable algorithms. Infrastructure improvements, such as enhanced computational power through GPUs and TPUs, and the expansion of internet connectivity and cloud infrastructure, also play a significant role.

Socio-economic factors highlight the economic and social benefits of AI. Economically, AI can increase productivity and efficiency across various industries and create new business models and job opportunities. Socially, AI can potentially improve the quality of life through AI-driven healthcare, education, and public services while also bridging the digital divide and promoting inclusivity.

The challenges and barriers to AI democratization are categorized into technical, societal, regulatory, and policy challenges (Table 3). Technical challenges include data availability and quality issues, such as the need for large, high-quality datasets and data privacy and security concerns. Scalability and performance are critical, involving computational power and energy consumption limitations and ensuring AI systems can handle real-world variability.

Societal challenges address AI's ethical and social implications, such as addressing AI bias and discrimination and managing the impact of AI on employment. Public awareness and acceptance are also crucial, which involves educating the public about the benefits and risks of AI and overcoming skepticism and resistance to AI adoption.

Regulatory and policy barriers involve the fragmented nature of AI regulations, with varying policies across different regions and the challenges in creating universal standards. Compliance and enforcement are essential to ensure adherence to ethical guidelines and monitor and mitigate AI technology misuse.

Table 2. Drivers of democratization.

Main Drivers	Drivers	Description
Technological Advancements	Innovations in AI Research	<ul style="list-style-type: none"> - Breakthroughs in machine learning, natural language processing, and computer vision - Development of more efficient and scalable algorithms
	Infrastructure Improvements	<ul style="list-style-type: none"> - Enhanced computational power (e.g., GPUs, TPUs, NPUs) - Expansion of internet connectivity and cloud infrastructure
Socio-Economic Factors	Economic Benefits	<ul style="list-style-type: none"> - Increased productivity and efficiency in various industries - New business models and job opportunities
	Social Impact	<ul style="list-style-type: none"> - Improved quality of life through AI-driven healthcare, education, and public services - Bridging the digital divide and promoting inclusivity

Table 3. Challenges and barriers.

	Challenges and Barriers	Description
Technical Challenges	Data Availability and Quality	<ul style="list-style-type: none"> - Need for large, high-quality datasets - Issues with data privacy and security
	Scalability and Performance	<ul style="list-style-type: none"> - Computational limits and energy consumption - Ensuring AI systems can handle real-world variability
Societal Challenges	Ethical and Social Implications	<ul style="list-style-type: none"> - Addressing AI bias and discrimination - Managing the impact of AI on employment
	Public Awareness and Acceptance	<ul style="list-style-type: none"> - Educating the public about AI benefits and risks - Overcoming skepticism and resistance to AI adoption
Regulatory and Policy Barriers	Fragmented Regulations	<ul style="list-style-type: none"> - Variability in AI policies across different regions - Challenges in creating universal standards
		<ul style="list-style-type: none"> - Ensuring adherence to ethical guidelines
	Compliance and Enforcement	<ul style="list-style-type: none"> - Monitoring and mitigating the misuse of AI technologies

Education and training are vital for building a knowledgeable workforce. This involves integrating AI education into school and university curricula and offering lifelong learning opportunities in AI. Skill development programs should provide training for various skill levels, from basic to advanced, and encourage interdisciplinary learning.

Ethical and responsible AI practices are essential for ensuring AI’s fair and transparent use. Inclusive AI development requires diverse representation in AI research and development teams, as well as designing AI systems that consider diverse user needs. Transparency and accountability involve implementing explainable AI models and establishing mechanisms for accountability in AI usage.

Table 4. Strategies for effective democratization.

	Strategies	Description
Collaborative Efforts	Public–Private Partnerships	<ul style="list-style-type: none"> - Joint initiatives between governments, academia, and industry - Sharing resources and knowledge
		<ul style="list-style-type: none"> - Involving diverse stakeholders in AI development
	Community Engagement	<ul style="list-style-type: none"> - Promoting open dialogue on AI-related issues

Table 4. *Cont.*

	Strategies	Description
Education and Training	Curriculum Development	- Integrating AI education into school and university curricula
	Skill Development Programs	- Offering lifelong learning opportunities in AI
		- Providing training for various skill levels, from basic to advanced
Ethical and Responsible AI Practices	Inclusive AI Development	- Encouraging interdisciplinary learning
		- Ensuring diverse representation in AI research and development teams
	Transparency and Accountability	- Designing AI systems that consider diverse user needs
		- Implementing explainable AI models
		- Establishing mechanisms for accountability in AI usage

6. Possible Scenarios of AI Democratization Framework

To analyze the impact of AI democratization using a scenario study approach, several scenarios were generated to understand potential outcomes and implications based on the theoretical framework.

Table 5 serves as a foundational framework for conducting scenario analysis on the democratization of AI. It identifies key variables and underlying assumptions crucial for understanding AI adoption’s potential outcomes and implications across different scenarios.

Table 5. Variables and assumptions.

Variable	Description	Assumption
Technological Advancements	Rate of innovation and availability of AI tools	AI technology will continue to evolve, but pace and direction are uncertain
Accessibility and Affordability	Extent to which AI tools and education are accessible and affordable	Efforts to democratize AI will vary in intensity and success
Governance and Regulation	Presence of effective policies and ethical guidelines	Policies and regulations will be developed, but their effectiveness will differ across scenarios
Public Awareness and Acceptance	Level of public understanding and acceptance of AI technologies	Public perception and understanding of AI will influence its adoption and integration
Economic Impact	Effects on productivity, job creation, and industry dynamics	The impact of AI will be shaped by the interplay of technological, economic, and social factors
Governance and Regulation	Presence of effective policies and ethical guidelines	Policies and regulations will be developed, but their effectiveness will differ across scenarios

Firstly, it considers technological advancements, recognizing that the rate of innovation and the availability of AI tools will significantly influence how AI is democratized. The assumption here is that AI technology will continue to evolve, but the pace and direction of this evolution remain uncertain, impacting accessibility and affordability. Secondly, accessibility and affordability are pivotal variables. The extent to which AI tools and education are accessible and affordable will vary, affecting democratization. Efforts to make AI accessible to a broader demographic will vary in intensity and success across different scenarios. Governance and regulation are crucial aspects that determine the ethical and legal frameworks guiding AI development and use. The assumption is that policies and regulations will be developed, but their effectiveness and international cooperation will vary, influencing AI’s overall adoption and impact. Professional organizations in computing and other disciplines do not easily fit within the frameworks of government agencies or non-profit institutions. Their roles are unique, and they are likely to significantly influence

the evolution of democratic processes—whether they support or challenge them. This influence may become apparent in different contexts, and many of their recommendations are likely to directly affect or engage with government policies and practices.

Public awareness and acceptance are critical variables that reflect the general public’s understanding and acceptance of AI technologies. Public perception and awareness play a significant role in the adoption rate and integration of AI into various sectors of society. Economic impact considers the effects of AI on productivity, job creation, and industry dynamics. This variable acknowledges that the interplay of technological advancements, economic factors, and societal readiness for AI adoption will shape the economic impact of AI. Lastly, social impact examines how AI adoption will affect the quality of life, inclusivity, and societal equality. This variable recognizes that AI can potentially reduce inequalities but may also introduce new challenges and disparities depending on how it is implemented and regulated.

Table 6 outlines several scenarios depicting potential trajectories for AI democratization based on the variables identified in Table 5. These scenarios provide a narrative framework to understand the range of possible outcomes, from current trends to disruptive innovations in AI technology. The baseline scenario describes a continuation of current trends with gradual improvements in AI accessibility and affordability. It assumes steady progress in AI tools and platforms, incremental policy updates, and moderate economic and social impacts. The optimistic scenario envisions rapid AI democratization driven by major technological breakthroughs, robust policy support, and widespread public acceptance. This scenario anticipates significant advancements in AI tools, comprehensive education programs, and substantial economic and social benefits. A pessimistic scenario considers slowed AI democratization due to technical, regulatory, and societal barriers. It assumes slow progress in AI technology and accessibility, fragmented regulatory efforts, and limited public engagement, resulting in minimal economic and social benefits. The disruptive scenario explores the introduction of groundbreaking AI technologies that fundamentally change the landscape. It anticipates sudden, significant breakthroughs leading to new applications and capabilities, with dynamic regulatory responses and balanced economic and social outcomes. Each scenario outlines specific key measures necessary to achieve its outcomes, involving different actors such as tech companies, governments, educational institutions, and the public. Technological advancements, accessibility, affordability, governance, public awareness, economic impact, and social impact are considered across all scenarios, reflecting their respective trajectories and potential impacts from 2024 to 2030.

Table 6. Scenario descriptions.

Component/Scenario	Baseline	Optimistic	Pessimistic	Disruptive
Description	Continuation of current trends with gradual improvements in AI accessibility and affordability	Rapid AI democratization driven by major technological breakthroughs, strong policy support, and widespread public acceptance	Slowed AI democratization due to significant technical, regulatory, and societal barriers	Introduction of groundbreaking AI technologies that dramatically change the landscape
Key Measures	Ongoing support for open-source AI projects, incremental policy updates, steady growth in AI education	Accelerated investment in AI research, comprehensive AI education programs, robust regulatory frameworks	Focus on mitigating negative impacts, targeted interventions in underserved areas	Rapid policy adaptation, continuous learning and training programs, proactive public engagement

Table 6. Cont.

Component/Scenario	Baseline	Optimistic	Pessimistic	Disruptive
Actors Involved	Tech companies, educational institutions, policymakers, general public	Governments, tech giants, educational institutions, NGOs, civil society	Policymakers, advocacy groups, local communities, select tech companies	Innovators, policymakers, educational institutions, tech companies, public
Technological Advancements	Moderate, steady progress in AI tools and platforms	Rapid advancements, frequent breakthroughs	Slow, incremental improvements	Sudden, significant breakthroughs leading to new applications and capabilities
Accessibility	Incremental increases in accessibility	Wide accessibility across sectors and demographics	Limited accessibility, significant disparities	Broad and rapid increase in accessibility, with new applications emerging quickly
Affordability	Gradual reduction in costs	Significant cost reductions, widespread affordability	High costs remain, limited affordability	Costs vary widely; some disruptive technologies may be expensive initially but decrease rapidly
Governance and Regulation	Incremental policy development and updates	Strong, comprehensive policy frameworks with international cooperation	Fragmented regulatory efforts, inconsistent policies	Dynamic and adaptive regulatory approaches, responsive to rapid technological changes
Public Awareness and Acceptance	Moderate increase in public understanding and acceptance	High levels of public engagement and positive perception	Low public trust, high skepticism	Mixed reactions; initial skepticism followed by eventual widespread acceptance
Economic Impact	Moderate economic growth, gradual productivity improvements	Significant economic growth, high productivity gains	Minimal economic benefits, potential job losses outweighing gains	Mixed economic impact; potential for both high growth and significant disruptions
Social Impact	Moderate improvements in quality of life, gradual reduction in inequalities	High social benefits, significant reduction in inequalities	Limited social benefits, potential increase in inequalities	Mixed social outcomes; some groups benefit significantly while others may initially be left behind
Road Map (2024–2030)	2024–2026: development of AI tools, increased availability of online AI courses; 2027–2029: gradual implementation of AI regulations, moderate improvements in public awareness; 2030: steady economic and social benefits, but disparities in AI adoption remain.	2024–2025: major AI breakthroughs, significant funding for AI research and education; 2026–2027: comprehensive AI policies, large-scale public awareness campaigns; 2028–2030: high AI adoption rates, substantial economic productivity gains, widespread societal benefits.	2024–2025: slow progress in AI technology and accessibility, high public skepticism; 2026–2027: fragmented regulatory efforts, limited public engagement; 2028–2030: minimal economic and social benefits, increased disparities and ethical issues.	2024–2025: emergence of disruptive AI technologies, immediate focus on adaptive policies; 2026–2027: widespread adaptive strategies, extensive public and stakeholder engagement; 2028–2030: high levels of innovation and adaptation, balanced economic and social outcomes.

Table 7 presents prioritized measures for immediate implementation to facilitate the democratization of AI. These measures are derived from the scenario analysis (Table 6) and the foundational variables (Table 5), emphasizing actions that stakeholders should take now to foster a responsible and inclusive AI ecosystem. Invest in AI education suggests expanding access to AI courses and training programs across all levels of education. This measure aims to equip individuals with the skills needed to participate in and benefit from the AI-driven economy. Promote open-source AI advocates for supporting the development and dissemination of open-source AI tools and platforms. Open-source initiatives enhance accessibility, encourage innovation, and mitigate barriers to AI adoption. Develop ethical guidelines recommends establishing comprehensive ethical guidelines for AI development and use. Ethical frameworks ensure that AI technologies are developed and deployed responsibly, addressing bias, privacy, and transparency concerns. Increase public awareness proposes launching campaigns to educate the public about the benefits and risks of AI. Public awareness campaigns foster informed discussions, mitigate skepticism, and build

trust in AI technologies. Foster collaboration encourages partnerships between government, industry, and academia to promote inclusive AI development. Collaboration facilitates knowledge sharing, aligns AI research and policy-making efforts, and ensures diverse perspectives are considered.

Table 7. Prioritized measures for today.

Measure	Description
Invest in AI Education	Expand access to AI courses and training programs across all levels of education.
Promote Open-Source AI	Support the development and dissemination of open-source AI tools and platforms.
Develop Ethical Guidelines	Establish and enforce comprehensive ethical guidelines for AI development and use
Increase Public Awareness	Launch campaigns to educate the public about the benefits and risks of AI
Foster Collaboration	Encourage partnerships between government, industry, and academia to promote inclusive AI development.
Power and energy needs	Countries should prioritize equitable access to sustainable energy to address the significant power demands of AI, especially in developing regions.

These measures are essential for laying the groundwork necessary for AI's ethical, equitable, and effective democratization. They reflect a proactive approach to addressing challenges and leveraging opportunities identified in the scenario analysis, aiming to maximize the societal benefits of AI while minimizing potential risks.

7. Discussion

In this discussion, we will explore the limits of democratization, its inclusivity and impact on underrepresented populations, the crucial need for validation in decision-making processes, and the growing demands for power and energy to support these advancements. Theoretical advancements and the development and validation of radically new algorithms should involve only those who are knowledgeable, aware, and competent, rather than just "everyone" or "anyone". Additionally, there is a concern over who is authorized to extend, modify, or transform public datasets, while private copies can be altered as necessary, acknowledging the risks involved. If such modifications are reflected in disseminated results, it is crucial that this information be transparently disclosed.

Democratization, inclusivity, and underrepresented populations: It is important to highlight that when discussing education, employment, and social issues, we should aim to encourage participation by women and underrepresented groups, from elementary education through to university and into the workforce. Another often overlooked issue is how to involve or at least inform older individuals, as AI will impact their lives too. Ensuring accessibility for people with disabilities or those facing perceptual challenges is also essential.

The need for validation: This applies in various areas. New algorithms must be tested, validated, and verified. Education should also address the problem of misleading results and hallucinations in large language models (LLMs) and provide guidelines for identifying these issues, many of which already exist. Additionally, all published algorithms and applications should go through security checks, and any results shared, especially from unverified sources, should undergo a security review.

Power and energy needs: Many AI algorithms, particularly those handling large datasets or complex calculations like LLMs, require substantial energy consumption. This issue is especially relevant for developing countries and certain regions. While it has been briefly addressed in some discussions, energy consumption poses a significant social fairness concern and requires thorough attention. Potential solutions include advancements in quantum computing, more efficient IT architectures, and the development of applications with lower power demands to mitigate AI's heavy energy consumption.

8. Conclusions

This paper presents a comprehensive framework for understanding AI democratization, focusing on key components, drivers, challenges, and strategies crucial to this transformative process. We also conducted a scenario analysis to explore potential futures for AI democratization, considering various factors such as technological advancement, accessibility, affordability, governance, public awareness, economic impact, and social implications.

From our scenario analysis, several significant insights have emerged. The pace and nature of technological advancements in AI will significantly influence its democratization. Rapid breakthroughs can accelerate adoption, while slower progress may pose barriers to widespread accessibility. Effective governance and regulatory frameworks are crucial for fostering responsible AI deployment. Comprehensive policies and international cooperation are essential to address ethical concerns, ensure data privacy, and promote equitable access. Public perception and understanding of AI play a pivotal role in its adoption. Initiatives to increase awareness and build trust are critical for overcoming skepticism and fostering inclusive AI development. The economic benefits of AI, such as increased productivity and new job opportunities, center on effective integration and management. Social impacts, including improved quality of life and reduced inequalities, depend on equitable access and ethical considerations. Strategic actions recommended today include investing in AI education, promoting open-source AI initiatives, developing ethical guidelines, increasing public awareness, and fostering collaborative efforts among stakeholders.

Looking ahead, several important areas for future research and practice stand out: Conduct longitudinal studies to track the evolution of AI democratization over time, assessing how different scenarios unfold and identifying emerging trends and challenges. Conduct rigorous impact assessments to evaluate AI deployment's economic, social, and ethical implications across diverse sectors and regions. Further, develop and refine regulatory frameworks to adapt to rapid technological advancements and ensure responsible AI development and usage. Deepen research into ethical considerations in AI development, mainly focusing on mitigating bias, ensuring transparency, and safeguarding privacy. Promote international collaboration to establish common standards and guidelines for AI governance, fostering a global dialogue on responsible AI practices.

This framework and scenario analysis provides a robust foundation for understanding the multifaceted aspects of AI democratization. By continuing to explore these dimensions and implementing strategic measures, we can navigate the evolving landscape of AI with foresight and responsibility. This approach ensures that AI technologies contribute positively to societal well-being and progress, fostering a future where innovation thrives alongside ethical considerations and inclusivity.

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References

1. Johnson, K. AI Democratization Depends on Tech Giants. Venturebeat. 2017. Available online: <https://venturebeat.com/ai/ai-weekly-ai-democratization-depends-on-tech-giants/> (accessed on 15 May 2024).
2. Sudmann, A. The Democratization of Artificial Intelligence. *Net Polit. Era Learn. Algorithms Transcr. Bielef.* **2019**, *1*. [CrossRef]
3. Himmelreich, J. Against “Democratizing AI”. *AI Soc.* **2023**, *38*, 1333–1346. [CrossRef]
4. Lukacz, P.M. Imaginaries of Democratization and the Value of Open Environmental Data: Analysis of Microsoft’s Planetary Computer. *Big Data Soc.* **2024**, *11*, 20539517241242448. [CrossRef]
5. Bildirici, F. Open-Source AI: An Approach to Responsible Artificial Intelligence Development. *REFLEKTİF Sos. Bilim. Derg.* **2024**, *5*, 73–81. [CrossRef]
6. Simon, F.M. *Artificial Intelligence in the News: How AI Retools, Rationalizes, and Reshapes Journalism and the Public Arena*; Columbia Journalism Review: New York, NY, USA, 2024. [CrossRef]
7. Turing, A.M. Computing Machinery and Intelligence. *Br. J. Mind* **1950**, *59*, 433–460. [CrossRef]
8. McCarthy, J. A Basis for a Mathematical Theory of Computation. In *Studies in Logic and the Foundations of Mathematics*; Braffort, P., Hirschberg, D., Eds.; Computer Programming and Formal Systems; Elsevier: Amsterdam, The Netherlands, 1959; Volume 26, pp. 33–70.
9. Hedges, D.W.D. Introducing Micro-Computers. *Clear. House* **1984**, *58*, 9–13. [CrossRef]
10. Raymond, E. The Cathedral and the Bazaar. *Knowl. Technol. Policy* **1999**, *12*, 23–49. [CrossRef]
11. Abadi, M. TensorFlow: Learning Functions at Scale. In *Proceedings of the 21st ACM SIGPLAN International Conference on Functional Programming, Nara, Japan, 18–22 September 2016*; Association for Computing Machinery: New York, NY, USA, 4 September 2016; p. 1.
12. Paszke, A.; Gross, S.; Massa, F.; Lerer, A.; Bradbury, J.; Chanan, G.; Killeen, T.; Lin, Z.; Gimelshein, N.; Antiga, L.; et al. PyTorch: An Imperative Style, High-Performance Deep Learning Library. In *Proceedings of the Advances in Neural Information Processing Systems, Berlin, Germany, 18–23 August 2019*; Curran Associates, Inc.: Red Hook, NY, USA, 2019; Volume 32.
13. Pedregosa, F.; Varoquaux, G.; Gramfort, A.; Michel, V.; Thirion, B.; Grisel, O.; Blondel, M.; Prettenhofer, P.; Weiss, R.; Dubourg, V. Scikit-Learn: Machine Learning in Python. *J. Mach. Learn. Res.* **2011**, *12*, 2825–2830.
14. Clough, P.D.; Otterbacher, J. Chapter 25: Democratizing AI: From Theory to Practice. In *Handbook of Research on Artificial Intelligence, Innovation and Entrepreneurship*; Edward Elgar Publishing: Cheltenham, UK, 2023; ISBN 978-1-83910-675-0.
15. Luitse, D.; Denkena, W. The Great Transformer: Examining the Role of Large Language Models in the Political Economy of AI. *Big Data Soc.* **2021**, *8*, 20539517211047734. [CrossRef]
16. Aparicio, S.; Aparicio, J.T.; Costa, C.J. Data Science and AI: Trends Analysis. In *Proceedings of the 14th Iberian Conference on Information Systems and Technologies (CISTI), Coimbra, Portugal, 19–22 June 2019*; pp. 1–6. [CrossRef]
17. Costa, C.J.; Aparicio, M. Applications of Data Science and Artificial Intelligence. *Appl. Sci.* **2023**, *13*, 9015. [CrossRef]
18. Garvey, C.K. On the Democratization of AI. In *Proceedings of the Datapower Conference, Ottawa, ON, Canada, 22–23 June 2017*; p. 5-3.
19. Garvey, C.K. A Framework for Evaluating Barriers to the Democratization of Artificial Intelligence. *Proc. AAAI Conf. Artif. Intell.* **2018**, *32*, 8079–8080. [CrossRef]
20. Ahmed, S.; Mula, R.S.; Dhavala, S.S. A Framework for Democratizing AI. *arXiv* **2020**, arXiv:2001.00818.
21. Nguyen, M.N.H.; Pandey, S.R.; Dang, T.N.; Huh, E.-N.; Tran, N.H.; Saad, W.; Hong, C.S. Self-Organizing Democratized Learning: Toward Large-Scale Distributed Learning Systems. *IEEE Trans. Neural Netw. Learn. Syst.* **2023**, *34*, 10698–10710. [CrossRef]
22. Marinakis, V.; Koutsellis, T.; Nikas, A.; Doukas, H. AI and Data Democratisation for Intelligent Energy Management. *Energies* **2021**, *14*, 4341. [CrossRef]
23. Chan, A.; Bradley, H.; Rajkumar, N. Reclaiming the Digital Commons: A Public Data Trust for Training Data. In *Proceedings of the 2023 AAAI/ACM Conference on AI, Ethics, and Society, Montreal, QC, Canada, 8–10 August 2023*; Association for Computing Machinery: New York, NY, USA, 29 August 2023; pp. 855–868.
24. Bermudez, I.; Traverso, S.; Mellia, M.; Munafò, M. Exploring the Cloud from Passive Measurements: The Amazon AWS Case. In *Proceedings of the 2013 Proceedings IEEE INFOCOM, Turin, Italy, 14–19 April 2013*; pp. 230–234.
25. Madhuri, T.; Sowjanya, P. Microsoft Azure v/s Amazon AWS Cloud Services: A Comparative Study. *Int. J. Innov. Res. Sci. Eng. Technol.* **2016**, *5*, 3904–3908.
26. Muhammed, A.S.; Ucu, D. Comparison of the IoT Platform Vendors, Microsoft Azure, Amazon Web Services, and Google Cloud, from Users’ Perspectives. In *Proceedings of the 2020 8th International Symposium on Digital Forensics and Security (ISDFS), Beirut, Lebanon, 1–2 June 2020*; pp. 1–4.
27. Saraswat, M.; Tripathi, R.C. Cloud Computing: Comparison and Analysis of Cloud Service Providers—AWS, Microsoft and Google. In *Proceedings of the 2020 9th International Conference on System Modeling and Advancement in Research Trends (SMART), Moradabad, India, 4–5 December 2020*; pp. 281–285. [CrossRef]
28. Aparicio, M.; Bacao, F.; Oliveira, T. MOOC’s Business Models: Turning Black Swans into Gray Swans. In *Proceedings of the International Conference on Information Systems and Design of Communication, Lisbon, Portugal, 16–17 May 2014*; Association for Computing Machinery: New York, NY, USA, 16 May 2014; pp. 45–49.
29. Aparicio, M.; Oliveira, T.; Bacao, F.; Painho, M. Gamification: A Key Determinant of Massive Open Online Course (MOOC) Success. *Inf. Manag.* **2019**, *56*, 39–54. [CrossRef]
30. Baturay, M.H. An Overview of the World of MOOCs. *Procedia-Soc. Behav. Sci.* **2015**, *174*, 427–433. [CrossRef]

31. Berryhill, J.; Heang, K.K.; Clogher, R.; McBride, K. *Hello, World: Artificial Intelligence and Its Use in the Public Sector*; OECD: Paris, France, 2019.
32. Ernst, E.; Merola, R.; Samaan, D. Economics of Artificial Intelligence: Implications for the Future of Work. *IZA J. Labor Policy* **2019**, *9*, 1–35. [[CrossRef](#)]
33. EU. The AI Act Explorer | EU Artificial Intelligence Act. 2024. Available online: <https://artificialintelligenceact.eu/ai-act-explorer/> (accessed on 16 June 2024).
34. White House. Blueprint for an AI Bill of Rights | OSTP. Available online: <https://www.whitehouse.gov/ostp/ai-bill-of-rights/> (accessed on 16 June 2024).
35. Amazon, A. Generative AI on AWS—Generative AI, LLMs, and Foundation Models—AWS. Available online: <https://aws.amazon.com/ai/generative-ai/> (accessed on 16 June 2024).
36. Google Gemini—Chat to Supercharge Your Ideas. Available online: <https://gemini.google.com> (accessed on 16 June 2024).
37. OpenAI ChatGPT. Available online: <https://chatgpt.com> (accessed on 16 June 2024).
38. Kong, S.-C.; Yang, Y. A Human-Centered Learning and Teaching Framework Using Generative Artificial Intelligence for Self-Regulated Learning Development Through Domain Knowledge Learning in K–12 Settings. *IEEE Trans. Learn. Technol.* **2024**, *17*, 1588–1599. [[CrossRef](#)]
39. Tală, M.L.; Müller, C.N.; Năstase, I.A.; Gheorghe, G. Exploring University Students’ Perceptions of Generative Artificial Intelligence in Education. *Amfiteatru Econ. J.* **2024**, *26*, 71–88. [[CrossRef](#)]
40. ACM. The Code Affirms an Obligation of Computing Professionals to Use Their Skills for the Benefit of Society. Available online: <https://www.acm.org/diversity-inclusion/code-of-ethics> (accessed on 16 June 2024).
41. IEEE. GET Program for AI Ethics and Governance Standards, GET. Available online: <https://ieeexplore.ieee.org/browse/standards/get-program/page/series?id=93> (accessed on 16 June 2024).
42. Baldassarre, M.T.; Caivano, D.; Fernandez Nieto, B.; Gigante, D.; Ragone, A. The Social Impact of Generative AI: An Analysis on ChatGPT. In *Proceedings of the 2023 ACM Conference on Information Technology for Social Good, Lisbon, Portugal, 6–8 September 2023*; Association for Computing Machinery: New York, NY, USA, 6 September 2023; pp. 363–373.
43. Bail, C.A. Can Generative AI Improve Social Science? *Proc. Natl. Acad. Sci. USA* **2024**, *121*, e2314021121. [[CrossRef](#)] [[PubMed](#)]
44. Kar, A.K.; Varsha, P.S.; Rajan, S. Unravelling the Impact of Generative Artificial Intelligence (GAI) in Industrial Applications: A Review of Scientific and Grey Literature. *Glob. J. Flex. Syst. Manag.* **2023**, *24*, 659–689. [[CrossRef](#)]
45. Soni, V. Impact of Generative AI on Small and Medium Enterprises’ Revenue Growth: The Moderating Role of Human, Technological, and Market Factors. *Rev. Contemp. Bus. Anal.* **2023**, *6*, 133–153.
46. Floridi, L.; Cows, J. Chapter 22: A Unified Framework of Five Principles for AI in Society. *Harvard Data Sci. Rev.* **2019**, *1*. [[CrossRef](#)]
47. Floridi, L.; Cows, J. A Unified Framework of Five Principles for AI in Society. In *Machine Learning and the City*; John Wiley & Sons, Ltd.: Hoboken, NJ, USA, 2022; pp. 535–545. ISBN 978-1-119-81507-5.
48. Floridi, L. Translating Principles into Practices of Digital Ethics: Five Risks of Being Unethical. *Philos. Technol.* **2019**, *32*, 185–193. [[CrossRef](#)]
49. Ortigossa, E.S.; Gonçalves, T.; Nonato, L.G. EXplainable Artificial Intelligence (XAI)—From Theory to Methods and Applications. *IEEE Access* **2024**, *12*, 80799–80846. [[CrossRef](#)]

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