

## LEVERAGING AI TECHNIQUES FOR EFFICIENT GOVERNANCE AND POLICYMAKING: REFLECTIONS ON AUTOMATA THEORY

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### **Abstract**

The worrisome issues of governance and policymaking in society can be addressed significantly by leveraging the techniques of AI and other advanced technologies for efficiency and optimization. This study examines the functionality of popular AI techniques in relation to automata theory (AT) in pursuing and realizing efficient governance and policymaking. The study relies on secondary data from library and the internet. It deploys thematic analysis, logical interpretation, and analytic descriptive techniques for synthesis and analysis of the data. The analysis shows that popular AI techniques, such as machine learning, deep learning, internet of things, robotics and natural language processing, perform multifaceted functions that optimize and automate governance and policymaking, thereby making various undertakings in these endeavours efficient, innovative and seamless. Besides, it demonstrates that AT offers valuable insights to understanding the behavior of machines and their interactional relationships with formal language. These findings underscore the dire need for leveraging AI techniques and other advanced technologies alongside practical conventional measures for the attainment of efficient governance and policymaking. Thus, the study concludes that AI techniques are capable of addressing many problems of governance and policymaking, including making them efficient to a large extent. For efficient governance and policymaking, stakeholders and experts in the fields are charged to be up and doing, proactive, engaging, decisive and committed to integrating and governing AI and other advanced technologies into policymaking and governance.

**Keywords: AI techniques, Governance, Policymaking, Efficiency, Automata Theory**

### **Introduction**

Historically and functionally, both Automata Theory (AT) and artificial intelligence (AI) are interdependent. Interestingly, the two are traced to Alan Turing and John von Neumann, who laid the foundation for the feats brought forth by machines in the today world (Lipnitskaya, 2024; DeCanio, 2020). By the 1950s and 1960s, finite-state machine (FSM), the mid-20th century foundational work of Alan Turing and John von Neumann got advanced by Edward F. Moore and George H. Mealy, who introduced two primary types of FSMs– Moore (1956) and Mealy (1955) machines. Accordingly, “Moore machines determine next states based solely on the current state, while the Mealy machines associate outputs with the current state and input, offering enhanced adaptability” (Lipnitskaya, 2024, p. 3). By implication, next decisions are influenced by current decisions. Current or latter decisions are outputs or outcomes of the

current decisions that become past decisions thereafter. Thus, current decisions ought to be made wisely and consciously. There is also the need to optimize decisions for efficiency and meaningful outcomes. As Nwode et al. (2024) note, “leveraging AI for policymaking entails computerizing or optimizing everything about policymaking for betterment” (p. 7).

Automata Theory is applied to AI usage in modelling and analyzing the behaviour of intelligent systems. Of course, AI techniques are intelligent systems. The Finite State Machine (FSM), a form of automata, models decision-making process, and identifies potential issues (Lipnitskaya, 2024). In the same vein, AI techniques are affirmed to be capable of playing varied functions, which can optimize, automate and revolutionize governance and policymaking. This study is aimed at making an analytic description of how AI techniques can be leveraged for efficient governance and policymaking. It has the objectives of presenting AI techniques, functions and benefits that make its adoption for policymaking and governance imperative.

### **Problem, Gap and Novelty**

There currently exists no significant scholarly engagement with AI in governance and policymaking. This assertion is given credence by Yigitcanlar et al. (2024), who observe that the current paucity of literatures on leveraging AI for governance underscores the need for research into that area of scholastic engagement. The present study is an attempt in that direction to contribute to research and development in the area of AI in governance and policymaking. It goes beyond that to making a reflection on automata theory (AT) in the leveraging of AI techniques for effective policymaking and governance. The foregoing points highlight the novelty of this study.

The paucity of literature on these thematic concerns poses limitation to the present study in terms of the extent of its engagement with previous studies. There are currently more unrelated extant studies on thematic concerns than the closely related ones. More so, Yigitcanlar et al. (2024) observe that the following areas of governance direly need AI techniques: planning, analytics, security, surveillance, energy, and modeling. As such, these areas in governance endeavor are not only lagging behind but also facing serious challenges that require technology-based interventions. Interestingly, AI techniques can be leveraged for the attainment of such goals.

Regrettably, many public and private sector organizations and stakeholders are yet to duly key into the use of AI for pursuing and realizing strategic goals, such as those advanced by the present study. A research of this kind on these laid-bare areas of governance would impact them positively and help proffer solutions to the challenges. Research is one of the viable means of addressing various societal challenges (Peter et al., 2023; Fadare, 2018). It is quite regrettable that there currently exists no significant volume of research on that. This study contributes to opening the eyes of some other researchers and drawing their attention to these understudied themes.

### **Leveraging AI Techniques for Policymaking**

Policymaking refers to “a plan or course of action,” considered to “be prudent or tactically-advantageous” by a government or an organization (Ahmed & Muritala, 2020, p. 331). From this definition of policymaking, leveraging AI for policymaking entails making logical plans or carrying out strategic actions that are advantageous in order to attain worthwhile results. In what reflects the foregoing, Ogbonnaya (2013) notes that policy is what serves as a blueprint for an official action having impacts on the masses. It is important to note that ‘policy’ and

‘policymaking’ involve ‘action’, ‘plan’, and a performer or performers, who carry out the plan or action. Thus, leveraging AI for policymaking entails government and/or organizations taking prudent actions, making rational plans, and deploying AI techniques for such purposes.

Drawing from the words of Ahmed and Muritala (2020) and Ogbonnaya (2013), this study avers that leveraging AI techniques for policymaking entails evolving and putting to effective use sustainable and realistic means of planning, strategizing and governing AI usage for various purposes and benefits. Similarly, Nwode et al. (2024) note that “leveraging AI techniques for policymaking means deploying the techniques of AI to pursue and realize a plan, a course of action, or thereabouts, which a government considers prudent for the realization of governance objectives” (p. 6). They add that “policymaking involves taking different decisions and actions” (Nwode et al., 2024, p. 6). The broad or multifaceted AI techniques, which can allow for the attainment of effective decision-making and governance, are itemized below:

**Table 1: AI Techniques for Effective Governance and Decision-Making**

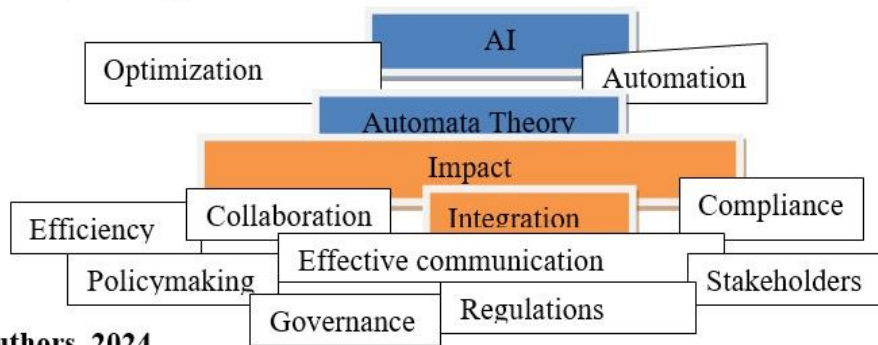
AI Subfields (Techniques)	Citations
Automated Machinery Systems	
Blockchain	Adewusi et al. (2024)
Computer Vision	Akinola (2024)
Deep Learning	Akinola et al. (2024)
Digital Image Analysis	Kodete et al. (2024)
Digital Twins	Nwode et al. (2024)
Faster R-CNN	Nwosu et al. (2024)
Generative Design	Ojo and Aghaunor (2024)
Internet of Things (IoT)	Okusi (2024a&b)
Machine Learning	Pasupuleti et al.
Natural Language Processing	(2024a&b)
Pattern Recognition	Peramo et al. (2024)
Real-time Analytics	Rasheed et al. (2024)
Reinforcement Learning	Thapaliya and Bokani
Robotic Process Automation	(2024)
Robotics	

**Source: Authors, 2024**

Clearly, the listed AI techniques are proven to be effective for purposes like governance and policymaking. Interestingly, these techniques aptly reflect and situate in AT. For emphasis here, the listed AI techniques are indeed affirmed individually and collectively by scholars to be capable of doing a lot in different endeavors. For example, Nwode et al. (2024), Okusi (2024b), and Pasupuleti et al. (2024b) indicate that Machine Learning (ML), Deep Learning (DL), Internet of Things (IoT), and Natural Language Processing.

Basically, the various AI techniques play independent and interdependent functions, for which the strong advocacy for their integration into conventional systems has been ongoing among scholars, some other individuals, organizations, groups, stakeholders, and even governments. Without claiming exhaustiveness, Pasupuleti et al. (2024b) represent the major technologies or techniques in the following diagram:

**Fig. 2: AI, Policymaking, Governance & Automata Theory**



**Source: Authors, 2024**

**Source: Pasupuleti et al. (2024b)**

It follows that the above represented AI technologies are influential and commonly in place. For the present study, BIM does not apply to governance and policymaking in non-engineering setting, while pattern recognition and digital twins and real-time analytics apply insignificantly compared to the others in the context of non-engineering governance and policymaking. Nwode et al. (2024) emphasize that the leveraging of AI techniques for policymaking would lead to achieving:

- (i) The conventional approaches to solving the issues would be improved, optimized and transformed.
- (ii) Enhancing and transforming policymaking.
- (iii) Getting more results, efficiency and productivity.
- (iv) Realizing the problem-solving potentials of AI technologies.
- (v) Improving and optimizing human efforts and performances in policymaking.

Although without AI techniques, policymaking and governance can still be in order, it is imperative to leverage the techniques for these activities in order to make them better and optimize and automate the activities involved. While there are other techniques to deploy for the attainment of effective policymaking, leveraging AI techniques for such purposes would yield more results. This point is upheld by Yigit et al. (2016), who note that AI technologies have to be integrated into other measures or systems for better results. Thus, they agree that AI technologies impact results of various activities wherever they are applied. Also, Nwode et al. (2024) and Jain and Jain (2019) indicate that the prospects or benefits of AI are what necessitate its adoption for innovations.

**AI Functions, Impact, Policymaking and Governance**

Studies share a standpoint on AI functions and impact in varied contexts and endeavors. Scholars, such as Akinola (2024), Akinola et al. (2024), Kamble and Gaikwad (2024), Obiuto et al. (2024), Nwosu et al. (2024), Okusi (2024b), Roshanaei et al. (2024), Singh (2024), Thuraka et al. (2024), Adefemi et al. (2023), Regona et al. (2023), Baker et al. (2020), Vantara (2020), and Wang (2019), are unanimous on the following core general functions of AI techniques:

- Data-driven decision-making
- Influencing effective planning
- Improving performance, services and operations
- Innovations
- Optimization
- Predictions and detections

- Reducing costs
- Saving time and resources
- Accountability
- Accuracy
- Advancement
- Compliance management
- Digitalization
- Enhancing teaching and learning
- Ensuring and increasing safety
- Incident reporting and response
- Inventions and discoveries
- Massive data creation, storage, dissemination and management
- Mitigating challenges to environmental sustainability

Essentially, AI techniques are needed for policymaking in order to prevent policy mistakes, errors, and inadequacies. Also, leveraging AI techniques for policymaking allows for innovations, optimization, efficiency, implementation, and lasting solutions to most of the issues given policy decisions and actions. The following Table 2 presents views expressed by some other scholars on the capability of AI techniques in various tasks, including policymaking and governance:

**Table 2: Selected Findings of Extant Studies on AI Impact**

<b>Studies</b>	<b>Findings</b>
Cugurullo (2024)	Many AIs are going out of human hands. Although humans have not lost control of AI, only a minority of the powerful stakeholders controls AI creation and diffusion.
Erman and Furendal (2024)	The current global AI governance frameworks lack criticality.
Thakur and Singh (2024)	Through its apps and tools (e.g. ChatGPT and transformer neural network architecture), AI has been transforming the 21st century society. With the advances in generative artificial intelligence, AIs with higher intelligence than human intelligence are expected to be produced.
Yigitcanlar et al. (2024) Efthymiou et al. (2020)	AI is currently being applied in many spheres of life beyond science and technology.
Medaglia et al. (2023)	In spite of the concerns about the governance of AI, trustworthy AI, impact assessment methodologies, and data governance, there has been an increase in the use of AI for governance and political purposes in recent times.
Pautz (2023)	The Scottish Government’s current limited use of AI is caused by its wariness of AI, ‘digital immaturity’ in its public sector, and varied ethical concerns about the use of AI.
Tallberg et al. (2023)	AI is a technological innovation having the huge potential of changing the human society.
Zhang et al. (2023)	College students have positive attitude towards the application of AI to political and ideological education.
Umoren et al. (2021)	AI helps equip humans with analytical skills.
Efthymiou et al. (2020)	AI can make campaigns more effective; compute electoral results accurately; and appropriately represent the large populations of nations like China, India, Russia, US and Nigeria.



Sætr (2020)	AI politics is a shallow defense of technocracy, which is characterized by problems needing ethical governance. To address AI politics and the attendant issues, there is the dire to utilize advanced strategic reasoning and analysis of vast amounts of data to solve complex problems.
Savaget et al. (2019)	AI and other technologies are rapidly transforming the political arena, particularly in terms of political activities like elections, and campaigns, leading to increase in political participation.
Manor (2017)	There shall be “future research on new technologies, inclusive of virtual reality for digitalization of diplomacy, drone for consular aid, 3D printing for foreign aid projects and cyber agreements on free movement of autonomous cars across borders” (p. 2).

**Source: Authors, 2024**

As evident in the Table 2, the impact of AI is commonly affirmed in the literature. The trends associated with it are also affirmed in the literature. In addition to the above noted points, using AI in governance can reduce subjective and biased decisions. The presence of AI in policymaking can foster favorable policy changes and systematized and popular decisions (Christou, 2019). The adoption of AI techniques for governance can lead to increased public participation (Yigitcanlar et al., 2024). The utilization of AI for governance allows for being proactive and taking preventive measures and solutions to address various issues at stake. Various governance and political activities are being monitored more efficiently with the use of AI techniques. Irregularities are identified and addressed proactively, accurately and efficiently with the use of AI techniques.

Machine and deep learning algorithms can influence timely and proactive addressing of issues or areas requiring improvement. The use of AI can lead to seamless efficient delivery of public services, with less costs and resources. That is, using AI for governance reduces costs of governance and the expenses of traditional or human-based policymaking. Politically, AI can be leveraged for plebiscite, opinion polls, campaigns, voting, elections, optimized and prediction of electoral results, and policymaking. AI has the capacity to analyze large amounts of data. It quickens and makes accurate various political undertakings. Machine learning algorithms can be used to gauge public opinion on national issues. The use of analytics allows for a more efficient allocation of resources. With the use of data analytics, demographic data and online behavior are analyzed accurately.

Given the foregoing, it is quite clear that AI enhances efficiency in governance and political activities. The overall governance, democratic and policymaking processes are impacted positively, as AI fosters public accountability and transparent governance and policymaking. AI techniques or technologies, such as Internet of Things and robotics, help make governance and policymaking seamless and easier. Also, by being capable of processing large volumes of data faster and more accurately, AI has a valuable place in governance. The computation capability links AI in governance and policymaking to automata theory (AT). AI also aligns with AT in predictions, detection and analytics.

Nonetheless, there are challenges and ethical concerns associated with leveraging AI for effective governance and policymaking. The following Table presents some major findings on challenges and ethical concerns about AI adoption for tasks, such as for purposes of governance and policymaking.

**Table 3: Challenges and Ethical Concerns**

<b>Studies</b>	<b>Findings</b>
Coeckelbergh (2024)	AI ushers in “democracy deficit”, keeping many out of governance processes.
Nwosu et al. (2024) Okusi (2024b) Green (2021)	Political scientists, ethicists, technologists, data and information scientists, cybersecurity experts, linguists, and such other professionals should collaborate meaningfully in finding lasting solutions to the ethical concerns arising from AI adoption and usage.
Jungherr (2023)	Amidst the affirmed benefits of AI, there are ethical concerns about its socio-economic, political and technological consequences. The prospects of AI are overstretched. Democracy is affected by electoral malpractices and ineffective leadership styles.
Tallberg et al. (2023)	The need for advancing towards addressing ethical issues of AI cannot be overemphasized. Both normative and empirical approaches to addressing the ethical concerns would yield more results and proffer more critical opportunities for good global governance. The subjection of AI to regulations is becoming global, because the ethical concerns it poses are in the public global space.
Gyulai and Ujlaki (2021)	The prescriptive accounts of AI development, use, and functioning are essentially political, with the political problem of unenforceability being at the apex.
Zuiderwijk et al. (2021)	Concrete, multidisciplinary and theoretical foundations for AI use can solve the issues associated with using AI for politics and public governance.
Efthymiou et al. (2020)	Ethical concerns and worries about the application of AI in various endeavors are being expressed. Stakeholders in various sectors ought to start developing AI-specific laws, improve existing laws, and make reforms that align with the current realities of the 21st century.
Sætr (2020)	The application of AI in politics raises some ethical concerns and causes harm.
Sætr (2020) Brkan (2019)	The harms caused by AI in governance, politics and policymaking include misinformation, and manipulation of data, results and electoral narratives.
Brkan (2019)	Unethical use of AI can leave untold effects on fair and free elections and democracy in Europe and other parts of the globe.
Frank (2019) Delponte & Tamburrini (2018)	Different spheres should become ready to adopt AI for their activities and strategize with workable multifaceted and integrative measures to address ethical and policy concerns about AI adoption.
Manheim and Kaplan (2019)	AI poses risks to data privacy and democracy. AI impacts politics and governance through its Big Data Analytics, Internet of Things and other techniques or subfields, influencing decision-making, behavioral profiles of citizens, predictions of results and other political activities.

**Source: Authors, 2024**

### **Automata Theory and Leveraging AI for Governance and Policymaking**

Lipnitskaya (2024) demonstrates that AT is a framework for designing, modeling simulating real-world AI systems in ways that lead to performance improvement, detection of issues, influencing decisions and using machines to improve tasks such as decision-making. She notes that finite-state machine (FSM) or finite automaton (FA) is a mathematical model for representing and analyzing “dynamic behavior of systems, whereby they are described through discrete states, transitions between those states, and a set of rules triggering these transitions” (p. 2). FSMs, used initially in digital circuits, obtain in both hardware and software applications. With these applications, systems assisted by AI can be leveraged for the detection of real-time object, and for designing complex systems that aid daily living.

In his engagement with Automata Theory (AT), Noam Chomsky identifies basic concepts of the theory to be states, transitions, input alphabets, and acceptance criteria (Chomsky, 1956). Although his engagement with AT is in the context of language, it reflects other contexts including those within which the present study situates. These concepts are of importance to the present study in the context of leveraging AI for effective governance and policymaking. Of course, as entities, states are involved in AI adoption, use and regulation. They ought to leverage AI for effective governance, policymaking, politics, administration, management, and so on. AI governance for ethical practices in AI usage is also to states, as political entities. The concept of transitions implies changes or innovations arising from the adoption of AI for governance and policymaking. It follows that there is need to transit from the traditional analogous means of governance and policymaking to AI-driven ones for the attainment of effectiveness, optimization and great feats.

The concept of “input alphabets” in AT also has a place in this study. The reason is that the use of AI for the purposes advocated by this study involves the use of the alphabets. In computation, not only figures are inputted; alphabets are also inputted. And, “acceptance criteria” underscores the concept of “AI governance”. That is to say, ethical governance of AI requires that the government and the stakeholders of sovereign states should evolve sustainable legitimate moral, ethical, legal, political and social “acceptance criteria”, with which citizens get guided in using AI for various purposes. It is quite obvious that AT captures AI conceptually and theoretically, and directly and indirectly. Interestingly, the fundamental concepts of AT reflect the thematic concerns of the present study.

Manalwar (2023) is of the view that AT has eight major areas of application. These are compiler design, text processing, robotics, DNA sequencing, determinism, cryptography, artificial intelligence, and networking. By having these areas, it is quite understandable that AI is an integral part of AT. Apart from determinism, which can translate as “acceptance criteria” or “ethical governance of AI”, the rest seven are all to computer science and also involve digital technologies too. Accordingly, AT provides frameworks for designing compilers and interpreters of programming languages. Thus, efficient digital generation of codes and various designs for political purposes involves both AT and AI. AT is also concerned with processing texts. AI techniques carry out text processing too. Both AT and AI provide ways for generating, analyzing and manipulating texts, expressions, codes and images, including those for political, governance and policymaking purposes.

Just like AI, AT is used in robotics and for the control of the behavior of robots. Since robots can be used variously for such purposes, it is quite clear that AI and AT reserve a valuable place in governance, policymaking and other public endeavors. Finite state machines are used to model and control robots for the performance of certain tasks. Although AT situates in



biology and bioinformatics, wherein it is used to analyze sequences and structures of DNA and formal languages, the present study does not concern biology and bioinformatics. However, it concerns informatics in governance and policymaking settings. The notion of determinism revolves around following established rules while engaging in computation, computerization, and revolutionizing of governance and policymaking tasks. Further, AT, like AI, is used for designing and analyzing encryption algorithms. By so doing, potential vulnerabilities are identified.

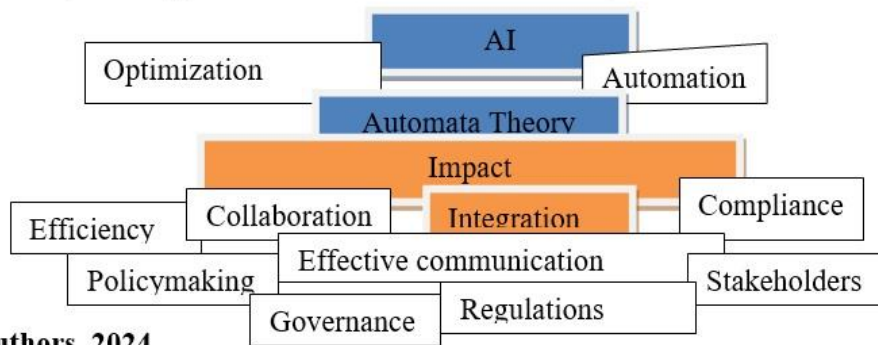
The use of AT in AI rests on its utilization for modelling and analyzing the behavior of intelligent systems. The modelling is applied in decision-making and the identification of potential issues needing lasting and systemic solutions. Finally, AT is utilized for modelling and analyzing the behavior of network protocols. The tasks undertaken in this context include identifying potential issues or risks, and modelling the flow of data between one device and another. AT has some limitations, just like AI. The limitations include:

- Limited computational power
- The restiveness of deterministic vs. non-deterministic parameters
- The inability to scale (sizes of) systems
- Issues and outcomes, the complexity of models and algorithms
- Inappropriate handling of errors
- Limited representation of problems and phenomena involved
- Being incapable of adapting to changing conditions
- The idealized rather than realizable models of AT do not give real-world accounts.

Adelani et al. (2024) and Govea et al. (2024) are of the view that the functions of AI (techniques) are why it is imperative to adopt AI (techniques) for human tasks such as policymaking, decision-making and governance in order to supplement human deeds and efforts, thereby producing more results. In particular, Adelani et al. (2024) and Govea et al. (2024) indicate that identification and prediction functions of AI, among others, are what make AI very important. In addition, Binhammad et al. (2024) express the view that AI models (techniques) have the capacity to organize, optimize, audit, provide large data, and strength human functions and performances. These are undoubtedly ways through which AI techniques impact governance, policymaking, and decision-making in various regards.

On their part, Nwode et al. (2024) argue that “AI decision-making techniques can be leveraged for effective implementation of policies” (p. 8). The foregoing expressed views justify the central viewpoint of the present study on AI techniques being capable of fostering as well as proffering efficiency in governance and policymaking. For this study, the idea of leveraging AI for effective governance and policymaking in relation to automata theory is presented in the diagram below:

**Fig. 2: AI, Policymaking, Governance & Automata Theory**



**Source: Authors, 2024**

## Conclusion

Indeed, automata theory (AT) offers valuable insights to understanding the behavior of machines and their interactional relationships with formal language. It contributes to discourses in computer science. The insights from Automata theory help in advancing trends in the field of computer science, including AI. In the context of this study, the theory offers insights to understanding the behavior of AI technologies, which are machines, in optimizing and automating decision-making in governance and policymaking. Research, such as this one, remains one tangible means of exploring the confines of AT and its application, as in the case of leveraging AI techniques for efficient policymaking and governance.

More research studies would help unveil and proffer considerable solutions to the challenges of composite systems, such as those associated with AT, AI, policymaking and governance. Stakeholders and experts in the concerned fields ought to be up and doing and make concerted efforts to address the inherent pressing issues at stake. These include leveraging AI techniques and other advanced technologies alongside pragmatic conventional measures for the purposes of efficient policymaking and governance.

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