

## Research Article

## Democratising Topology and Toopologising Democracy

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## Abstract

We critically examine the role topology plays in describing democracy and how it can be utilized to create a more sustainable future for humanity.

## 1. Introduction

The relationship between democracy and topology may initially seem tangential, as the two belong to vastly different realms: democracy pertains to political science and governance, while topology is a branch of mathematics dealing with the properties of space preserved under continuous transformations. However, a closer analysis reveals intriguing intersections where the abstract principles of topology can metaphorically illuminate the dynamics of democratic systems.

## 2. Topological Perspectives on Democratic Structures

At its core, topology is concerned with connectivity and the continuity of structures. Similarly, democracy relies on the interconnectedness of its institutions and citizens. A democratic society can be thought of as a network, where individuals, institutions, and laws form a complex web of relationships [1].

Topology provides tools to study such networks, focusing on how they hold together or change under various influences. For instance, concepts like nodes and edges in graph theory—a field closely related to topology—can represent voters and the relationships between them, such as shared interests, alliances, or communication pathways [2].

Consider the idea of a “topological space” in mathematics, which is defined by a set of points and a topology that describes how these points relate to one another [3]. In a democracy, these points could represent individual citizens, and the topology could symbolize the mechanisms of participation and representation that bind them together. Just as topology examines how spaces remain connected despite transformations, democratic resilience depends on its ability to adapt to societal changes while maintaining its core principles of representation and accountability. Historical examples, such as the transition from absolute monarchies to constitutional democracies, demonstrate how systems can reconfigure their “topological”

structures (sometimes adding extra dimensions to the problem) to enhance inclusivity and representation [4,5].

## 3. Continuous Transformations and Democratic Adaptation

One of the most significant concepts in topology is the idea of continuous transformations. A shape can be stretched or deformed without tearing it, and it remains topologically equivalent to its original form. This idea parallels the flexibility and adaptability of democratic systems. Democracies often face internal and external pressures—such as shifts in public opinion, technological advancements, or economic crises. To endure, they must adapt without losing their essential characteristics, such as the rule of law, the protection of minority rights, and the legitimacy derived from free and fair elections.

For example, the rise of digital communication platforms has transformed how citizens engage with their governments and each other. This shift is akin to a topological transformation: the underlying structure of public discourse has been stretched and reshaped [6]. However, the democratic “space” remains intact if it continues to facilitate open dialogue, participation, and accountability. Similarly, transitions from one form of electoral system to another—such as from majoritarian to proportional representation—can be seen as topological adjustments aimed at achieving greater fairness and inclusivity [7].

## 4. Topological Invariants and Democratic Principles

In topology, certain properties of spaces, known as invariants, remain unchanged under continuous transformations. These include characteristics like the number of holes in a shape or its connectivity. Similarly, democracies possess core principles that must remain invariant to preserve their identity. These principles—such as equality, liberty, and justice—serve as anchors that ensure the system’s integrity, even as its surface features evolve.

For instance, constitutional frameworks can be viewed as topological invariants within a democratic system. While laws and policies may change over time, the foundational principles enshrined in a constitution provide continuity and stability. These invariants act as safeguards, ensuring that the system remains recognizable as a democracy despite external or internal transformations. Topological cretinism is another invariant potentially relevant to democratic societies, but it is beyond the scope of this paper to study it in detail.

The U.S. Constitution, for example, has undergone numerous amendments but retains its commitment to foundational ideals such as freedom of speech and equal protection under the law [8].

## 5. The Role of Topological Defects in Democratic Systems

In topology, defects or discontinuities in a structure can reveal critical insights into its stability and behavior. Similarly, examining “defects” in a democracy — such as voter disenfranchisement, corruption, or unequal representation — can highlight vulnerabilities and areas requiring reform. Addressing these defects is essential to maintaining the system’s coherence and functionality.

For example, gerrymandering — the manipulation of electoral district boundaries — can be viewed as a disruption in the topological space of representation. By analyzing the connectivity and fairness of electoral maps through computational topology, policymakers can identify and rectify such distortions to restore democratic integrity. Scholars such as Moon Duchin have applied geometric and topological methods to identify and mitigate gerrymandering, emphasizing the potential of mathematics to promote fairer democratic practices [9].

Another relevant issue is the emergence of “information bubbles” in digital communication spaces, with or without artificial and intelligence [10]. These bubbles can create topological separations within the public sphere, leading to polarization and fragmentation. Understanding and bridging these divides through tools inspired by network topology could foster greater cohesion and understanding among citizens [11].

## 6. Conclusion

While democracy and topology operate in distinct domains, their intersection offers a rich metaphorical framework for understanding the dynamics of governance. Topology’s emphasis on connectivity, continuity, and invariants provides valuable insights into the resilience and adaptability of democratic systems. By viewing democracy through a topological lens, we gain a deeper appreciation for the structures and principles that sustain it, as well as the transformations it must navigate to endure in an ever-changing world. Future interdisciplinary research could further explore these connections, offering novel strategies to enhance democratic resilience and equity in the face of global challenges.

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## Disclaimer

The views are our own, no ethical issues identified, and no living being has been exposed to experiments.

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