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Original Article

Digital technologies and migration: behind, beyond and around the black box

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Abstract

Digital technologies have often been criticised for functioning as "black boxes" due to their complexity and opacity, which make it difficult to understand their inner mechanisms and outputs. This article presents the conceptual framework for this special issue, which aims to shift the focus away from viewing technology merely as a "black box." Our primary objective is to contribute to the literature on digital technology–driven migration governance by moving beyond descriptions of digital technologies ("explaining the black box") towards examining their established relationships, transformations over time, and both immediate and hidden consequences — that is, exploring the effects "behind, beyond, and around the black box." Guided by these three principles, we advocate for a more nuanced analysis that examines both the continuities and discontinuities brought about by these technologies, rather than viewing them as entirely new phenomena. This approach redirects attention from the technology itself to an exploration of how these technologies are integrated within social contexts, thereby (re)shaping power relations among various social actors. Finally, we set aside normative judgments about the intrinsic value of these technologies to foreground how multiple actors engage with, resist, or repurpose them in their everyday lives.

Key Words: *Digital technologies, black box, migration governance, conceptual framework, social context.*

Introduction:

The rapid evolution and widespread adoption of digital technologies over the past two decades have significantly shaped the fields of *migration management* and border control (Amoore 2011; Bigo and Guild 2005; Broeders et al. 2016). This transformation has given rise to new terminologies such as *smart borders* (Hayes and Vermeulen 2012), *iBorder* (Pötzsch 2018), *bio-bordering* (Amelung and Machado 2019), *digital borders* (Chouliaraki and Georgiou 2022), and *digital racial borders* (Achiume 2021). The growing literature on technology-driven migration governance reflects the increasing use of interoperable databases, automated algorithmic decision-making systems, and other digital tools in migration control. These technologies are now integrated into multiple aspects of border and migration management, including facial recognition systems, ground sensors, aerial surveillance drones, and partially automated systems for migration and asylum decision-making.

In this special issue, we build upon this expanding body of scholarship on digital technologies by defining them as tools that reconfigure *human–machine configurations* (Scheel 2024; Suchman 2007). This definition, informed by Science and Technology Studies (STS), allows us to conceptualise agency as *socio-technical, distributed, and relational* (Scheel 2024, 2293), rather than as a binary contrast between human and non-human actors. Scholars have increasingly emphasised the central role of datafication in mobility and migration management (Bigo, Isin, and Ruppert 2019; Leese, Noori, and Scheel 2022; Nedelcu and Soysüren 2020; Ponzanesi 2019). However, these technologies have also been criticised for operating as *black boxes.* To clarify our use of the term *black box*, we refer to Latour's (1987, 131) concept in *Science in Action*, where it describes a complex network of interconnected actors functioning as a single automaton—where the whole exceeds the sum of its parts.

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In this article, we use *black box* to describe systems or technologies whose internal workings remain opaque, whether due to technical complexity, intentional secrecy, or the assumption that their outputs should be accepted without scrutiny. The main aim of this special issue is to move beyond perceiving technology merely as a *black box*. Rather than limiting ourselves to describing the relationship between migration and technology ("explaining the black box"), we seek to examine how this relationship is shaped by social dynamics, evolves over time, and produces both visible and hidden consequences. In other words, we explore the broader implications of digital technologies—looking *behind, beyond, and around* the black box. Our contribution lies at the intersection of critical border studies, migration studies, and technology studies. First, we examine both the continuities and transformations brought about by digital technologies, questioning assumptions of their novelty and analysing how claims of innovation influence research narratives. Second, we shift attention from the technologies themselves to how they are embedded within social contexts, reshaping relations among diverse actors such as state authorities, international NGOs, migrants, and private companies. We also consider how similar technologies may be used differently by distinct actors (e.g., local versus national governments). Our approach moves beyond moral or value-based judgments about whether these technologies are inherently beneficial or harmful. Instead, we highlight how various actors—depending on their social and political positioning—engage with, resist, or repurpose these technologies in everyday life. This perspective challenges the binary assumption that state and industry uses are solely oppressive while migrant uses are inherently empowering. Consequently, the contributors to this issue provide nuanced analyses of both migrant and state engagements with digital technologies as they relate to migration governance. In the following sections, we outline our analytical framework, summarise the contributions of each article, and propose directions for future research

Behind the Black Box: Reproduction or Rupture:

"Behind the Black Box" refers to examining both the continuities and discontinuities produced by digital technologies. While these technologies undoubtedly generate new practices and infrastructures, they often rely on and reproduce longstanding rationalities. This approach challenges dominant narratives of novelty that prevail in industry and policy discourses, where technologies are often portrayed as *"silver bullet"* solutions — a perspective commonly termed *"techno-solutionism."* In this issue, we argue that many new practices reinforce existing logics of control, surveillance, and classification. The overemphasis on the transformative potential of digital technologies has limited the development of nuanced analyses that consider the historical processes underlying their use. By shifting our analytical focus from merely exploring the relationship between migration and technology to considering the historical and temporal dimensions of technology use in migration management, we aim to identify both continuities and ruptures in border and migration governance, as well as the broader implications of ongoing digitalisation. Thus, this issue seeks to understand how digital technologies materialise and reinforce pre-existing systems of migration governance while also introducing elements of novelty. Furthermore, we interrogate what claims of "newness" do to the study of digital technologies and migration—both ontologically and epistemologically. In the European context, recent scholarship has explored how nation-states and supranational organisations, such as European Union (EU) agencies, employ digital technologies to produce knowledge about migrants (Bellanova and Glouftsios 2022; Latonero and Kift 2018; Pelizza 2020; Pollozek and Passoth 2019). Marin (2011) introduced the concept of the *"cyber-fortress"* to describe the various processes through which the EU integrates digital technologies into migration governance. This body of work has examined the growing interoperability of migration databases, including their connections with police databases (Aden 2020; Blasi Casagran 2021; Valdivia et al. 2022; Vavoula 2022), and how security rationales justify this technological expansion (Amoore 2013; Longo 2017; Martins and Jumbert 2022). Such studies demonstrate that digital data are never neutral; they are actively produced through invisible infrastructures and practices that shape what is recorded, how it is interpreted, and how it is applied (Bowker et al. 2009; Mackenzie 2017). Building on this literature, we examine the historical trajectory and influence of technology-driven migration governance without falling into *technological determinism*. We do not assume that digital technologies necessarily or immediately produce new effects. Instead, we see them as operating within broader socio-technical systems of migration governance. As earlier scholarship has shown, governing populations through biometrics is not new—it traces back to colonial practices (see Cole 2001). The concept of *"data colonialism"* helps explain how digital data capture and processing continue extractive logics of power and control, particularly across what is referred to as the *"Global South."* This occurs through enduring *"data relations"* between the Global North and South (Couldry and Mejias 2019; Ricaurte 2019; Thatcher, O'Sullivan, and Mahmoudi 2016). Couldry and Mejias (2019) further reveal how data exploitation mirrors historical patterns of labour and land extraction. Similarly, the concept of *"techno-humanitarianism"*—emerging at the intersection of colonial politics of aid and humanitarian intervention—lays the groundwork for critically examining the role of digital technologies in migration governance from a historical perspective (Abdelnour and Saeed 2014; Tazzioli 2022; Weitzberg et al. 2021). This scholarship shows that the *power asymmetries of humanitarianism, data, and innovation practices* are being reproduced by digital tools and *colonial relationships of dependency*, a phenomenon identified as *"techno-colonialism"* by Mirca Madianou (2019, 1). However, *data colonialism* is not confined to humanitarian contexts in the Global South. Emerging research on *data capitalism* highlights how digital data are exploited as material resources for economic expansion in the Global North as well (Ricaurte 2019; Sadowski 2019). Studies on

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bias and injustice in algorithmic systems demonstrate their harmful effects on racialised, low-income, and migrantised populations in the Global North (Eubanks 2018; Molnar 2024; Noble 2018). This body of work exposes how exploitative and extractive data practices (Gray and Suri 2019), along with applications of artificial intelligence (AI), dispossess precarious populations of their resources (Keyes 2018; Stark 2019). In summary, this issue argues that power relations can be both historically rooted and continuously reproduced, while also exhibiting elements of novelty and transformation. The contributors move beyond the framework of data colonialism to examine power formations that cannot be fully explained through a colonial lens. For example, Weitzberg (2025) goes beyond the familiar notion of *"function creep"* as merely an outcome of sovereign, capitalist, or colonial logics. Similarly, Jablonowski (2025) identifies a broader *"societal transformation,"* drawing on Deleuze's notion of *"societies of control,"* where power operates through continuous and decentralised technologies. We, therefore, focus on how technologies function within existing social processes to trace where and how elements of newness may emerge. We also call for further critical engagement with how framing digital technologies as *"novel"* generates urgency and shapes research agendas. This observation aligns with Tazzioli's (2023) warning against *"techno-hype"* in migration studies. Future research could further integrate co-productionist approaches from Science and Technology Studies (STS), as suggested by Trauttmansdorff and Felt (2023), to examine these (dis)continuities. Ultimately, we aim to look *behind the black box* by investigating the historical foundations shaping the development and implementation of digital migration technologies. The articles in this issue analyse both the historical and contemporary contexts in which these technologies are introduced, adopted, and promoted—whether by state authorities (see Jablonowski 2025; Leurs et al. 2025; Ozkul 2025) or international organisations such as the United Nations High Commissioner for Refugees (UNHCR)—and the (un)intended consequences these processes produce for affected populations over time (see Weitzberg 2025

Beyond the Black Box: Shifting and Redefining Relationships:

"Beyond the Black Box" refers to examining how digital technologies are embedded within broader governance structures—both influencing and being influenced by multiple, differently positioned actors. With this issue, we aim to contribute to ongoing debates by building on emerging scholarship at the crossroads of Science and Technology Studies (STS), critical migration studies, and border and security studies (see Amelung et al. 2020; Glouftsios and Scheel 2021; Trauttmansdorff and Felt 2023). Our approach aligns with arguments from this field that new bordering processes, practices, and subjectivities arising from technological innovation are deeply connected to their social contexts and to the situated positionalities of those implementing and subjected to them (Martins and Jumbert 2022). For instance, Godin and Donà (2020) introduced the concept of *"techno-borderscapes"* to describe sites of embodied and virtual encounters among diverse state and non-state actors that reveal the intersections between digital securitisation, humanitarianism, and activism, thereby rethinking the nature of transit zones. By moving beyond binaries, we shift the focus from describing individual technologies to understanding the interactions between the digital and the analogue, as well as the broader contexts—state, non-state, public, and private—within which digital technologies are embedded. In doing so, we move *beyond* conventional understandings of technology as a mere *"black box."* Rather than separating human and non-human elements, STS—particularly in the traditions of actor-network theory and feminist science studies—emphasises the *performativity* of practices, viewing them as complex, mutable, and contested socio-technical networks. As Scheel notes, "instead of different perspectives, more-or-less accurate measurements, or more-or-less adequate representations of existing realities 'out there', knowledge production becomes a question of what Mol (2002) calls 'ontological politics'—that is, a question of what kinds of realities are enacted through particular knowledge practices and how these versions of the real are negotiated" (Scheel 2024, 2293). This focus on the performativity of knowledge practices draws attention to those implementing digitalised migration systems. For example, Ozkul (2025) illustrates how the German Federal Office for Migration and Refugees (Bundesamt für Migration und Flüchtlinge, BAMF) seeks to establish a data-driven *"constructed objectivity"* in its asylum procedures through the introduction of digital technologies. Here, technology is framed as a tool to rationalise what is, in essence, a subjective process. However, as Ozkul shows, this framing overlooks the fact that technology is never neutral; it inherently embeds subjective judgments about applicants' identities. Similarly, Leurs et al. (2025) examine mobile phone data extraction in the Netherlands, analysing how this practice reshapes social relations and symbolic meanings. Through a case study of smartphone data screening in Dutch asylum procedures, they offer valuable insights into how, when, and why cultural encounters shape digital borders. In the context of digitised migration and asylum systems, recent scholarship challenges the assumption that decision-making is being entirely delegated to machines. While some argue that technology reduces the discretion of border guards by minimising human involvement (Leese, Noori, and Scheel 2022; Magalhães 2018), emerging research suggests that, in certain contexts, technology may actually *amplify* discretionary practices rather than diminish them (Vrăbiescu 2020). As Scheel (2024, 6) argues, discretion must be understood as *"sociotechnical and material"* rather than purely human. Caseworkers rely on a combination of material devices, technologies, formal and informal rules, bureaucratic routines, institutional guidelines, architectural settings, and their own experiences and intuition (ibid). In Norway, for instance, immigration authorities use algorithms to allocate welfare to asylum seekers based on factors such as age, family size, application status, and type of reception centre (Ozkul 2023). Yet, due to algorithmic bugs, the system requires frequent manual

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oversight and correction (Ozkul 2023). Hence, rather than eliminating human roles, digitalisation transforms them. It introduces loopholes, glitches, and opacities that make it essential to understand how officers navigate these technologies in their daily work. A more nuanced understanding of the *state*—and the entanglement of state, market, and technology—enables us to capture how both state and non-state actors shape the operational field of digital migration governance. Jablonowski (2025) shows how the digitalisation of immigration status management has restructured the internal hierarchy of the UK Home Office, giving greater authority to IT specialists. Meanwhile, Weitzberg (2025) examines *"double registration"* in Kenya, where citizens register with both the national government and the UNHCR to access humanitarian aid and protection. This phenomenon reveals the harms of biometric systems when viewed within broader logics of sovereignty and exclusion. Humanitarian biometric initiatives do not exist in isolation; they are often intertwined with state gatekeeping mechanisms and exclusionary distinctions between *"insiders"* and *"outsiders."* Thus, by going *beyond the black box*, we can explore how digital technologies are embedded within complex governance structures and how they both influence and are influenced by diverse actors. This perspective allows for a deeper understanding of how digitalisation reconfigures authority, discretion, and relationships across migration governance networks.

Going Beyond Traditional Binaries:

This issue emphasises the need for digital migration studies to move beyond traditional binaries, both theoretically and empirically. As mentioned earlier, the Global North–Global South binary can be unhelpful when exploring the wider effects of technology-driven migration governance beyond immediate outcomes. Drawing on Science and Technology Studies (STS), instead of viewing human and non-human forms of agency as separate and opposed, we can conceptualise digital technologies as reconfigurations of existing human–machine relationships (see Scheel Citation2024). A less technocentric perspective allows researchers to better understand the multifaceted nature of border regimes, which may be low-tech or high-tech, digital or non-digital, occurring either simultaneously or at different moments and across various spaces. Indeed, low-tech and high-tech border practices often operate together in everyday humanitarian and law enforcement contexts. These complex entanglements shift throughout a migrant's journey, as Canzutti and Tazzioli (Citation2023) note, emphasising the need to 'excavate digital–nondigital assemblages'. The articles in this issue demonstrate that both state and non-state actors, as well as migrants, often use a mix of old and new technologies in practice. For instance, Leurs et al. (Citation2025) show how Dutch Border Police officers engage in digital bordering by combining manual inspections with automated analysis of mobile phones to identify asylum applicants. Greater attention should therefore be given to understanding how such hybrid 'border assemblages' function. Furthermore, by examining the emergence of new actors and relationships within digital migration and border regimes, we can move beyond the binary of 'state' versus 'migrants'. This issue, for example, explores the roles of private technology companies and social media platforms as corporate actors that influence asylum and integration processes, as well as the involvement of humanitarian organisations in bordering practices. It also highlights how refugee-led organisations can reshape narratives about refugees (Godin and Ghislain Citation2025) and how local authorities, through firewall practices, can counter hostile environment policies to form 'digital sanctuaries' (Humphris et al. Citation2025). Future research that considers the state as a heterogeneous entity, recognises non-state actors as authoritative institutions with distinct intentions and capabilities, and examines migrants' diverse aspirations and skills can help transcend traditional binaries. Additionally, analysing how digital technologies alter power dynamics within and among migrants and institutions of authority will enable more nuanced understandings. Overall, this introduction calls for a relational and historically grounded approach to studying digital technologies rather than deterministic interpretations. Building on emerging scholarship, we advocate analyses that are nuanced, context-specific, and attentive to the historical and social positioning of actors. We propose three guiding principles — 'behind', 'beyond', and 'around the black box'. First, 'Behind the Black Box' investigates the temporal and historical embeddedness shaping the development and implementation of digital migration technologies. Second, 'Beyond the Black Box' examines how these technologies are situated within broader governance structures, influencing and being influenced by diverse actors. Finally, 'Around the Black Box' highlights how multiple actors engage with, resist, or repurpose these technologies in everyday life.

Conclusion:

So, the articles in this issue, argues that digital technologies should not be seen as disruptive innovations but as extensions of long-standing mechanisms of control embedded within historical patterns of migration governance. Adopting a relational perspective inspired by STS, we assert that power is not only exercised from the top down but also distributed across technologies, infrastructures, bureaucratic processes, and human actors. Both state and non-state actors — including humanitarian organisations, private technology firms, and migrant-led groups — shape and are shaped by these systems. For instance, while national governments may deploy digital technologies to enforce stricter border controls, municipalities can repurpose the same tools to counter restrictive policies. To capture these contestations, we advocate for multi-scalar, grounded research that examines how different actors, including migrants, interact with and reshape digital infrastructures, and how these interactions produce new forms of subjectivity. Thus,

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this Special Issue advances a relational approach that studies the specific uses of digital migration technologies through the lens of Actor-Network Theory (ANT) and feminist Science and Technology Studies (STS), recognising that power is distributed among humans, technologies, and infrastructures alike.

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