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EXPLORING APPIFICATION

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This panel offers a reflection on the evolution and transformations of apps and app studies over the past decade, emphasising how apps have seamlessly integrated into our daily routines and shaped our cultural and economic landscape. This process, known as ‘appification’, involves integrating various aspects of daily life and activities into mobile applications, fundamentally altering how we communicate, access information, make payments, and use digital services (Dieter et al., 2019; Goggin, 2021; Morris and Murray, 2018). Research in app studies has evolved in multiple directions during this time to analyse the implications of appification. This includes examining how app interfaces and features influence social, cultural, and economic practices, employing methods such as the walkthrough method or feature analysis (Hasinoff and Bivens, 2021; Light et al., 2018). Additionally, there is a focus on the technical and material dimensions of data infrastructures where apps are situated (Gerlitz et al., 2019). Simultaneously, the emergence of new app genres, like ‘super apps’, which combine features, services, and practices in unique ways, has transformed apps into platforms for further development. However, this evolution also raises methodological questions on researching and contextualising change over time (Helmond and van der Vlist, 2021). The evolving and dynamic nature of apps, accordingly, necessitates a continuous need for critical reflection on the methods used to study apps and the phenomenon of appification.

The panel explores the concept of ‘appification’ through various lenses, including governance and safety measures in dating apps, the integration of AI technologies into mobile and enterprise applications, the historical evolution of Chinese super apps, and the complexities of app-based authentication. Methodologically, the panel showcases diverse strategies to explore ‘appification’, such as the walkthrough method, creating research personas, decompiling and debugging app software packages, historical analysis using app repositories, and analysing mini-apps and app store inventories. Together, these studies provide insight into emerging approaches for understanding appification going forward and how apps are reshaping interactions, governance, and technology integration across different domains and cultural contexts.

All five papers in this panel engage with the concept of ‘appification’, which entails the integration of various aspects of daily life into mobile applications, fundamentally changing how we communicate, access information, conduct transactions, and use digital services. The first paper employs the walkthrough method to explore how dating apps shape the notion of ‘safety’ through their policies and technological features, shedding light on how safety measures are often traded for data and how these apps normalise surveillance practices. The second paper investigates the appification of dating by examining Tinder’s authentication mechanisms, revealing the complexities of user interactions and data exchanges within the app ecosystem. Advancing the field of app studies, the panel thus explores methodological strategies and conceptual frameworks to address the nuances of appification. The third paper maps out the global landscape of ‘super apps’ and theorises the process of ‘super-appification’, where apps extend beyond their traditional boundaries to offer a wide range of features and services, reshaping user engagement and corporate expansion. A comparative historiography of prominent Chinese super apps forms the basis of the fourth paper,

tracing their evolution, features, and strategies driving their dominance. Lastly, the fifth paper examines the emerging ecosystems of AI apps, exploring their infrastructural features and relationships. Together, these studies provide a comprehensive overview of the ongoing transformations in the mobile ecosystem and the appification process, highlighting the crucial role of app features in shaping social interactions and corporate strategies.

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‘PROVE TO OTHER USERS THAT YOU’RE A REAL PERSON’: TRACING DATING APPS’ CARCERAL LOGICS

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Introduction

Across decades, dating apps have been the locus for moral panics, which position this technology as a scapegoat for the ongoing stigmatisation of casual sex and women’s sexual agency (Albury, 2018). However, users experience violence and threats to safety through these apps in myriad forms: discrimination, harassment, sexual aggression, privacy breaches, and more (Filice et al., 2022; Dietzel, 2021; Carlson and Frazer, 2020; Gillet, 2018). Apps are often reactive in response, providing a patchwork of features, guidelines, and campaigns to dissuade moral panics while appearing to address actual harms (Duguay et al., 2018). Further examination is necessary to identify dating apps’ approaches to establishing safety and their limitations for protecting users.

App Governance and Safety

Apps’ regulation of safety—and sexuality—requires attention, given the censorship, surveillance, and algorithmic control that shapes user experiences. Digital platforms have restricted, censored, and removed sexually suggestive content, banned profiles deemed to violate community guidelines, or implemented algorithms that suppress certain types of sexual content (Paasonen et al., 2024). This deplatformisation of sexuality (Tiidenberg and Van Der Nagel, 2020) can have significant implications for marginalised communities, especially LGBTQ+ people, sex workers, and others who may be stigmatised or criminalised by app companies (Blunt et al., 2021). This conflation of safety and sexuality underscores the need for critical engagement with the socio-technical infrastructures and policies that mediate people’s app-related experiences.

Scholars have increasingly identified carceral logics functioning through platform governance. Platforms enlist users to report each other while automated moderation systems surveil user activity in ways that reinforce racist and sexist policing (Gray and Stein, 2021; Pajé et al., 2023). Feminist scholars of color describe carceral feminism as 'an overreliance on carceral approaches to solve the problem of gender violence, despite research that clearly establishes that the carceral regime harms Black and other people of colour and other marginalised groups' (Davis et al, 2022: 42). Carceral feminist approaches prioritise individualised violence rather than systemic harms while valorizing surveillance and punitive legal processes (Pajé et al., 2023). As dating apps exist within a broader platform landscape that aims to 'protect' individuals from sexuality but still need to address actual harms, critiques of carceral feminism provide a lens for understanding how their safety mechanisms function and whom they protect.

Methods

This study is part of a larger research project investigating digital harms associated with dating apps in Canada. For this portion, our team used the walkthrough method (Light et al., 2018) to examine 30 dating apps. We purposively sampled these apps from the Canadian App Store (iOS) and Google Play (Android) according to downloads, rankings, and diversity of user populations. The sample includes popular apps (e.g., Bumble, Tinder) and those catering to minority identity publics (e.g., BLK, Dil Mil, Lex, Salams).

The first phase of data collection and analysis involved gathering each app's relevant policy documents (e.g., terms of service), guidelines (e.g., community standards), and safety information. These materials were uploaded to NVivo and qualitatively coded (Saldaña, 2021) through open coding, followed by categorical coding, to identify themes pertaining to app companies' discursive constructions of safety. The second phase will involve a 'technical walkthrough' (Light et al., 2018: 891), examining apps' interface arrangements, functions, features, text, and symbolic representations. Field notes will be recorded to identify how apps' safety approaches are realised through technical mechanisms. Both phases will be complete by Fall 2024.

Preliminary Findings

Individualization of Responsibility

Many dating app companies have responded to safety concerns by individualising user responsibility. For example, Grindr's 20-page 'Holistic Security Guide' (n.d.) does little to explain how 'Grindr is continuously seeking to develop and improve its security features.' Instead, it explains how the onus falls on users to manage their safety, advising them: 'Don't use personal info in your Grindr profile,' 'Hide distance in your Grindr profile,' and 'Don't connect your social media accounts.' These recommendations run counter to Grindr's features, including default displays of proximity and options to integrate social media profiles. Such discourse reflects the neoliberalism of carceral logics (Kim, 2020) that render individuals responsible for their protection while only offering protection to citizens who follow prescribed processes for maintaining safety.

Reliance on Co-moderation

Most apps encourage users to report and block ‘a member’s offensive behaviour’ (happn), ‘if you’re being harassed’ (Coffee Meets Bagel), or in ‘any instances of misconduct and violations of our policies’ (Dil Mil). While apps reassure their users that ‘reports of harassment, intimidation and assault are taken very seriously’ (Plenty Of Fish), blocking and reporting rely on users to identify and address problems and, in the case of Dil Mil, be familiar with what constitutes ‘violations of [their] policies.’ App documentation indicates that companies are aware of malicious reporting, with Badoo stating, ‘Intentionally reporting another member solely based on a protected attribute will not be tolerated.’ However, apps often employ automated moderation processes that fail to detect targeted reporting motivated by discrimination (Gray and Stein, 2021). Moreover, co-moderation cultivates peer surveillance with punitive results that remove individuals from communities without recourse, rehabilitation, or community-led justice that could cultivate cultural shifts in systems of discrimination (Bailey and Cole, 2021).

Surveillance and Datafication as Protection

Several apps have introduced automated mechanisms that aim to protect users, including verification features that compare user selfies to profile photos. The result is often a profile badge that Badoo and others tout as ‘identity verification,’ whereby you can ‘prove to other users that you’re a real person, making it easier to make friends and potential matches.’ Being a real person is premised on consistent visual appearance, reflecting the tendency of computer vision toward ‘physiognomic AI’ that assesses physical attributes to draw unsubstantiated conclusions about one’s character (Stark and Hutson, 2022). Another increasingly common feature, Badoo’s ‘Rude Message Detector’ claims to ‘detect any text that could be perceived as rude, abusive, homophobic or discriminatory,’ and it relies on automated word detection, with specific phrases triggering prompts that ask users if they want to continue chatting or block/report their match. Across these mechanisms, safety is exchanged for access to more user data gleaned through normalised surveillance. Akin to how carceral logics calling for greater urban police presence most effectively protect white, middle class women (Kim, 2020), increased dataveillance results in more negative outcomes for, and greater social control of, racialized and LGBTQ+ people (Benjamin, 2019; Liu, 2020).

Conclusion

Carceral logics are most apparent in the streamlined connections some apps have established with police or third-party security companies. This includes Tinder’s integration of Noonlight, which signals emergencies to a private monitoring company, or Match’s ‘Date Check-ins’ that prompt users to call 9-1-1 if a date turns dangerous. Such features presume that all users feel comfortable and protected by these authorities. Their logic aligns with carceral feminism’s emphasis on police, state, and – increasingly under neoliberalism – profit-based forms of protection to establish women’s safety, the main issue in moral panics surrounding dating apps. However, our preliminary findings show that carceral logics also function through policies that individualise user safety, emphasise co-moderation enabling targeted blocking, and rationalise heightened dataveillance. Using these subtle measures, app companies appear to address safety issues while creating technical arrangements that can be used to police and punish those who are already at risk of systemic violence.

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APPIFICATION AS AUTHENTICATION: FORMATTING THE USER IN THE TINDER ECOSYSTEM

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Introduction

Tinder has become synonymous with its own actions in contemporary dating, from ‘swiping right’ to matching. These very actions are a key part of the app's popularity, with its many imitators usually copying the fundamental swipe and match-actions with their own twist. What comes through is that the simplicity of a swipe drives this courtship grammar. In this paper, we argue that such a simple action belies a complex ecosystem in which the pursuit of a potential partner is formatted into a series of gestures on a screen, transferring what might take place in the physical realm—an encounter, a romantic discernment, an ‘approach’—into the application's interface. We uncover the economy of gesture, time, and user data that results from this reformatting, and how it is not driven by the sole easement of a connection.

The Authentication of the Everyday

Tinder is but one part of contemporary attempts to understand, analyse, gamify, and monetise love. Tinder's move to build an infrastructure around the historically ineffable emotion is part and parcel of a new language of connection. Yet these very attempts to mechanise (or monetise) romance often raise the question of the ‘authenticity’ of a connection made when it is mediated. How have dating apps come to substitute for, or, as some would argue, effectively replicate, the experience of authentic romantic connection—a supposedly unmediated and unmotivated thing? The appeal of romance lies in its promise of transcendence beyond the transactional, espousing a connection wherein one has the chance to be their true self, appearing as a place that requires authenticity. This paper engages with the questions: How is a ‘user’ perceived from the app's viewpoint? And how and when does the app align interactions between the user and the server?

To investigate these questions, we explore the manifold ways that Tinder recreates a sensation of authenticity, especially as tied to romantic connections, through its application infrastructure—specifically, how users and those they meet (or don't) on the app are deemed authentic romantic options in Tinder's social pool. A growing body of digital research centres around the study of ‘authenticity’ and ‘authentication’ (Burton, Chun et al., 2023), encompassing fields such as media studies and disinformation studies. The starting point for this paper is the consideration of how platforms format their users through various practices of configuring individuals with data in the multi-sided market of the platform. Authentication, central to digital interactions, is the process

by which something or someone is verified as true against predefined standards. This concept is intricately linked to ‘appification’, as Dieter and Tkacz (2020) describe, where software transforms everyday actions into structured digital interactions. This transformation is evident in platforms like Tinder, where actions such as swiping become a form of user engagement and identity validation within the app's framework. The notion of a ‘grammar of action’ further illustrates how digital platforms structure user activities into recognizable patterns, effectively embedding authentication into the user's interaction with the app (Gerlitz et al., 2019; cf. Agre, 1994). Through this lens, appification not only redefines everyday activities but also establishes a reciprocal authentication process where users and platforms validate each other, encapsulating the dynamic interplay between human agency and digital architectures.

Methods

Methodologically, this paper outlines an approach and framework for the analysis of platform authentication, drawing on existing research in app studies (Dieter et al., 2019) and app debugging techniques. We use the ‘research persona’ concept (Bounegru et al., 2022) as a tool in the walkthrough method (Duguay and Gold-Apel, 2023) to investigate user authentication, examining how user activity is formatted and captured in the interface. In parallel, we analyse network traffic to understand machinic authentication, which we define as the crucial network-level exchanges between the user's device and the servers that ensure the platform’s functionality. To demonstrate the practical application of this methodological approach and framework, we present a case study of Tinder.

Findings

Our research highlights the dual construction of personas and characters at both the user interface and the backend, revealing a substantial disconnect between frontend activities and backend processes. Notably, the authentication experienced by users at the interface level diverges significantly from network-level activities, emphasising the multi-layered and often imperceptible nature of authentication processes. In media studies, it is often presumed that the grammar of action embedded within a medium eventually aligns with user activity. However, our analysis revealed a significant disconnect between frontend activities and backend processes. This discrepancy was evident not only in what is recognized as a meaningful event but also in the temporality of these interactions. The study showed that the way users are authenticated by an app at the network level—the communication between the phone (as a client device) and the server(s)—is radically different from user activities observed at the interface level. Our examination of network flows versus interface flows highlighted that authentication is a multi-layered affair, often imperceptible to the user. Contrary to what might be expected, user activities do not always coincide with backend authentication processes. There are distinct, often independent activities occurring at various levels that subtly influence the overall experience.

Appification relies on authentication throughout the points of contact—user, interface, and backend or server—and each of these layers incorporates a different temporality that works together to construct the application. User temporalities are, in a sense,

suspended through the desubjectifying flow of the swipe actions. The application's time is punctuated by a separate set of events, alongside events that are of significance for the user's flow state, during which data events occur sparingly and in richness. The network, meanwhile, maintains a steady state of connection through the low layers of the protocol stack. In turn, these temporalities buttress the authentication processes at play. Users authenticate themselves as romantic possibilities through mutual interactions on and with the interface; the app likewise authenticates itself with advertisers through continued usage of the app. Likewise, the machinic forms of authentication that take place through the network's repeated contact with the application are less punctuated by events and more punctuated by a promiscuity of transfer and sustained contact between the user's device and the server. This shows that appification of dating is a thorough combination of different temporalities based on the mutual authentication processes of different protocols, layers, and applications of user data exchange. Appification thus emerges through the intersection of these different temporalities and the different means by which they authenticate these different points of contact as cohesive and constitutive of the infrastructure of the app.

Conclusion

Crucially, this paper highlights the research affordances of 'authentication', emphasising that it is neither a clearly defined concept nor consistently understood across different research areas. For this study, we consider authentication in a twofold manner: the authentication of the user by the app and machinic authentication. Following a 'digital methods' approach, this study views authentication not only as an object of study but also as a tool for analysis—a concept to be understood and utilised (cf. Rogers, 2013). This perspective involves understanding and working with the intricacies of app software and network connection tools, highlighting the need to understand and adapt to the unique characteristics of app-based platforms.

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SUPER-APPIFICATION: MAPPING THE GLOBAL LANDSCAPE OF 'SUPER APPS'

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Introduction

'Super apps' are on the rise and are distinguished by a wide range of seemingly unrelated services built onto a core functionality, creating an immersive and unified experience for everyday activities that resembles both an operating system and brand. For Chan (2022), a super app is like 'a single app that allows you to shop for groceries, pay your rent, review work documents, refill prescriptions, book a trip, and chat with friends, interest groups, and businesses'. Here, the term 'super' does not necessarily mean superb or indispensable, but rather refers to an app that goes beyond a single-purpose activity to combine many different services across typically isolated industry sectors.

Existing scholarly research and industry observers have highlighted several pivotal features of super apps. Firstly, super apps are understood as applications that incorporate multiple services in one place. They are described as 'all-in-one apps' (Chen et al., 2018), 'Swiss-army-style apps' (Steinberg, 2020) or 'do-everything apps' that represent 'a particular model of an app that assumes most functions of the smartphone can be done within either a single app or a suite of apps' (Steinberg et al., 2022: 1409). Secondly, super apps are understood as a specific type of corporation or business strategy. Goggin (2021: 77) describes them as 'an integrative technical, user, and business approach to leverage existing customer bases and to expand into other product and service opportunities'. Super apps are viewed as the outcome of specific corporate strategies, including conglomeration and financialisation (Jia et al., 2022), as 'digital platforms that leverage a business' core assets across multiple use cases or service verticals' (Ajene, 2021), and are considered both 'a product and a form of organising value' (Chai, 2021). Finally, super apps are conceptualised as 'mega-platforms' to highlight new forms of enclosure by powerful 'megacorps' like Tencent. According to Chen et al. (2018: 5), super apps function as mega-platforms to expand and grow, with their ability to 'glue together an increasing array of activities'. They evolve into super apps by becoming a platform for other applications to develop within (Steinberg, 2020), as demonstrated by Tencent's WeChat (Chen et al., 2018; Plantin

and De Seta, 2019), Facebook Messenger (Nieborg and Helmond, 2019), or LINE (Steinberg, 2020). This leads to a form of enclosure in which super apps commodify various types of mobile and networking services into their platforms (Goggin, 2021: 76).

Mapping 'Super-App Constellations' Worldwide

Despite various critical viewpoints, previous studies on super apps have predominantly focused on individual apps or app companies situated in China and Southeast Asia. Examples include WeChat, Tencent, LINE, Gojek, and Grab. Notably, a report from the Platform Lab discusses nine Asian-focused apps, albeit through individual case studies (Pitre, 2022).

This study delves into the features, origins, and varied expressions of the worldwide phenomenon of super apps through an extensive and juxtaposed examination, asking: *what* are super apps, *who* develops them, *when* did they emerge, and *where* are they prevalent? Rather than aiming to identify one particular type of app, we introduce the notion of 'super-app constellations', illustrating how mobile apps have transformed into platforms and platforms have adopted app-like characteristics in a larger trend we term 'super-appification'. Beyond individual popular examples like WeChat in China, East Asia, and Southeast Asia, our analysis of 41 super apps from around the world reveals four distinct types of super-app constellations, reflecting different patterns and dynamics of conglomeration, which we call the 'Swiss Army Knife', 'Family', 'Host', and 'Hub'. As such, we are the first to provide a *global* perspective on super apps, not only in terms of geographic scope but also our comprehensive overview of the phenomenon as a whole.

Theorising 'Super-Appification'

Our study underscores that apps attain their 'super' status by incorporating a variety of crucial everyday services across sectors and borders within super-app constellations. The conceptualisation and classification of super-app constellations offer a broader insight into the diverse patterns and dynamics of conglomerate integration propelling super-appification in the global digital economy, encompassing a spectrum of corporate, developmental, and international expansion strategies. Therefore, as we propose, super-appification aligns with the mechanisms of 'platformisation', conceived as the process driving the infrastructural and economic expansion of platforms into new online domains (Helmond, 2015); nevertheless, it exhibits unique characteristics, wherein services from disparate industries coalesce into a unified constellation, a process we refer to as conglomeration. Driving these dynamics is the ambition of super-app companies to embed themselves ever more deeply into individuals' daily routines, seising and capitalising on a broad range of essential everyday activities.

We identify four distinct types of super-app constellations, each exhibiting unique patterns of conglomeration. 'Swiss-Army-style' super apps expand their service offerings within a single app, consolidating industries previously served by separate app companies. 'Family' apps expand through their app and company portfolios, extending services and entering new markets through subsidiaries. 'Host' and 'Hub'-style super apps leverage third-party developers to provide complementary services, capitalising on network effects either internally or through an external app ecosystem. This typology

lays the groundwork for understanding 'super-appification' both as a form of conglomeration in the digital economy and as an app-specific form of platformisation. Unlike platformisation, which involves a single platform branching into new sectors, app conglomeration generates various distinctive forms by bundling services into unique constellations, potentially as a regulatory circumvention strategy.

The analysis of super-app constellations illustrates how these apps are typically embedded within corporate infrastructures and leverage their networks and subsidiary-company portfolios to expand their services and enter new markets. While some may be awaiting the emergence of Western super apps like WeChat, it is important to adopt a broader view and acknowledge the diverse types of super apps that already exist across different world regions. This showcases the regional variations and complexities of the super-app model, underscoring the need for a global perspective when investigating the cultural and economic dimensions of mobile apps and platforms.

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THE EVOLUTION OF CHINESE SUPER-APPS: A COMPARATIVE HISTORY OF ALIPAY, MEITUAN AND WECHAT USING APP REPOSITORIES

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Introduction

This paper offers a historical exploration of the phenomenon of 'super-appification' in China, focussed on a comparative analysis of Alipay, Meituan, and WeChat. While discourses around 'super-apps' are often entangled with promotional narratives and hype, recent research in digital media studies has suggested the term nevertheless reflects an increasing concentration of corporate media power within the global platform and app economy—a process characterised by dual tendencies of *platformization* and *appification* leading to the emergence of integrated service ecosystems encompassing communication, financial transactions, transportation and delivery, and more (Pitre, 2022; Steinberg et al., 2022; Van der Vlist et al., 2024). Notably, apps like WeChat have been frequently cited as quintessential examples of this trend (Chan, 2022), aligning with critical examinations of such platforms that have broadly considered their governance structures and infrastructural consequences (Plantin and de Seta, 2018; De Kloet et al., 2019), as well as their pervasive entanglement with socio-political dynamics of daily life (Harwit, 2017; Chen et al., 2018). Following methodologies of multi-situated app studies (Dieter et al., 2019), our contribution in this paper aims to provide valuable empirical detail to these discussions by focussing on the granular, technical aspects of super-app design and development. By developing a series of comparative historical studies supported with data visualisations and structured by key themes of infrastructuralization, datafication and platform governance, we aim to clarify how super-appification has materially unfolded in the Chinese context, drawing attention to its evolving technical and operational frameworks.

Methods

Our paper advances methodological approaches to app historiography by expanding multi-situated app studies to new modes of diachronic analysis. Typically, such approaches to researching apps have adopted a more synchronic approach by repurposing platform and app infrastructures, often involving static 'snapshots' of data collection. In contrast, our research introduces novel longitudinal methodologies for apps research that capture the evolving nature of software development over time. Accordingly, drawing inspiration from recent biographical studies of websites (Rogers,

2017) and platforms (Burgess and Baym, 2020; Helmond and Van der Vlist, 2019), we consider how apps such as Alipay, Meituan, and WeChat have played an active role in 'authoring' their own historical trajectories through being situated within digital infrastructures (Helmond & Van der Vlist, 2021). To operationalize this perspective, we leverage traces of software versioning sourced from industry data, web archives, and app repositories in conjunction with digital tools like scrapers, decompilers, and code inspectors. A key resource in our work is AndroZoo, a large-scale app repository hosted by the University of Luxembourg, which contains over 24 million Android application packages and their metadata collected from various marketplaces. While AndroZoo has mainly supported research on app descriptions, malware detection, app permissions, and GDPR compliance (Alecci et al., 2024), its potential for interdisciplinary studies of media concentration and the phenomenon of super-appification remains underexplored. Our inquiry, therefore, in addition to documenting the specificities of Chinese super-app development, reflexively considers the challenges associated with utilising such complex app archives, including their technical limitations, and the need for diverse methodological considerations to adequately ground research findings.

Tracing Conglomeration Over Time

As indicated, our analysis is organised by themes of infrastructuralization, datafication and platform governance. For the former, we begin by reviewing the overall approach taken to super-appification through taxonomies that have been proposed based on four general frameworks: the 'Swiss Army Knife' (the 'do everything' app), 'host' (apps with an internal ecosystem that supports mini-app programs), 'hub' (apps with an external ecosystem facilitated by an API), and 'family' (whereby a company expands by offering a diversity of specifically-targeted apps, often unified by a single brand) (Van der Vlist et al., 2024). Here, we draw attention to hybrid strategies taken up by Alipay, Meituan and Tencent (owner of WeChat), emphasising in particular to conglomeration processes taking place through families of apps, which enables diversification, experimentation and the negotiation of regional specificities, including regulatory frameworks. We also delineate the evolution of these super-apps via chronological analysis, highlighting the rapid integration of new services and the amalgamation of multiple sectors within Alipay, Meituan, and WeChat by drawing from app descriptions and industry data (specifically SensorTower and data.ai).

In terms of datafication, we turn our attention to the analysis of the widely recognized importance of permissions and software development kits (SDKs) (Dieter et al., 2021; Pybus and Coté, 2024) to trace a signature dynamic over time whereby known third-party trackers are gradually reduced, while device permissions expand to facilitate datafication across the expanding range of services. This will include an analysis of sensor data, an aspect typically not communicated to app end-users. We also zoom into 'launcher' permissions—specific protocols which facilitate consistent user-experience across various device environments—as a method to trace and map the deep integration of super-apps with dominant smartphone manufacturers, including, for instance, Samsung, Sony, Huawei, Oppo and Meizu, among others. We additionally consider securitization patterns both in terms of the capacity to unpack apps for analysis and their general features given the prominence of secure payments. Finally, regarding governance, we turn to key changes and patterns against a timeline for the introduction

of protocols and developer guidelines for the Android system, along with significant political events and social controversies associated with platform governance, while reflecting on possibilities and challenges of grounding insights through such correlative analysis. We conclude with an analysis of processes of parallel platformization (Kaye et al., 2020) through the evolution of Chinese and international versions of these super-apps over time, including key differences between Tencent's Weixin and WeChat, and recent initiatives such as international versions of Alipay and Meituan's expansion into Hong Kong through KeeTa.

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THE APPIFICATION OF AI: EMERGING APP ECOSYSTEMS AND INFRASTRUCTURES

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Introduction

This paper explores emerging AI app ecosystems, focusing on their infrastructural features and relationships. It draws on digital research in Internet studies, social media, platform studies, and app studies to conceptualise and analyse what we term the ‘appification of AI’, as AI technologies become integral parts of daily life through apps.

The ecosystem metaphor helps understand the relations and power dynamics among a core platform, its actors (platform owner, third-party app developers, users), and the apps developed on it (Van der Vlist, 2022). It offers a relational perspective, showing how apps are shaped by their environments, inhabited by various actors. Building upon the concept of an ‘infrastructural turn' in media and internet research (Hesmondhalgh, 2021; Plantin et al., 2018), our work extends previous research on appification (Dieter et al., 2019, 2021; Goggin, 2021; Morris and Murray, 2018) and delves into the infrastructural dimensions of apps (Blanke and Pybus, 2020; Flensburg and Lai, 2023; Gerlitz et al., 2019).

While different concepts of infrastructure exist, they share an interest in ‘the mundanity and ordinariness of existing systems’ and ideas of materiality and relationality (Hesmondhalgh, 2021). In digital media studies, this involves examining the software and hardware layers supporting everyday social processes, such as mobile apps and smartphones. Our methodology aims to map and characterise app ecosystems, analyse embedded infrastructures, and reveal data relationships linking various entities (Dieter et al., 2019; Dieter et al., 2021; Van der Vlist 2022; Van der Vlist et al., 2024).

To illustrate our methodological approach, we conducted a case study of AI app ecosystems and infrastructure. The technology industry has promoted the ‘democratisation of AI’ (Burkhardt, 2020), making development tools accessible to a broader range of developers. AI apps, created by diverse developers, showcase AI's potential and diverse applications, driving expectations and exploration across domains. Examining app ecosystems around AI technologies and their infrastructure offers insights into their technical and economic foundations and integration into the digital ecosystem. As AI becomes embedded in daily life through apps, understanding their

ecosystems and infrastructural dynamics is crucial for policy development and examining monopolistic practices.

Analysing Emerging AI App Ecosystems

The paper analyses AI apps, spanning multiple platforms. It explores AI apps across different platforms, such as mobile app stores, model marketplaces, and cloud marketplaces from leading providers like Amazon, Microsoft, and Google. This broader perspective on the appification of AI allows us to discern distinct types of AI app ecosystems. By focusing on this evolving landscape, the study highlights the maturation and stabilisation of AI technology through extensive app development (Van der Vlist et al., 2024).

Specifically, the study investigates three types of AI app ecosystems: (1) AI-powered apps in mobile app stores (Apple's App Store and Google Play), (2) AI apps in OpenAI's GPT Store, and (3) AI apps on cloud platform marketplaces like Microsoft Azure Marketplace.

The first approach involves locating AI apps in app stores by querying for relevant terms, resulting in a substantial number of apps on both iOS and Android platforms. Detailed analysis of these apps uncovers complex infrastructural aspects, including tracking practices, permission protocols, and hidden data mechanisms (Flensburg and Lai, 2023; Gerlitz et al., 2019a). This analysis sheds light on infrastructural power dynamics and monopolisation tendencies. Here, apps are understood as dynamic conglomerations of microservices, shedding light on infrastructural power and monopolisation, as shown by previous studies of decentralised software development kits (e.g., Blanke and Pybus, 2020; Pybus and Coté, 2024).

The second approach focuses on the GPT Store, exploring governance and affordances for developers. It analyses the categories and application domains of custom GPTs, offering insights into their integration into various social and cultural domains. This shows how the GPT Store serves as an ecosystem for developers to innovate, generate value, and facilitate user interactions within environments governed by OpenAI. We gathered available GPTs from the Store to examine their categories and application domains, enriching our comprehension of how a large language model like ChatGPT is applied across various social and cultural contexts.

The third approach examines cloud marketplaces offered by major providers, revealing a wide array of AI apps and machine-learning models tailored for cloud deployment. These marketplaces play a crucial role in bridging AI technologies with enterprise software, facilitating the spread of AI systems across various industries (Van der Vlist et al., 2024). AI infrastructure heavily relies on cloud infrastructure services. This dependence is not only evident in AI apps found in app stores but also in the multitude of AI-related apps present in cloud platform marketplaces. Comparable to app stores, these cloud marketplaces offer a variety of (enterprise-focused) apps and machine-learning models specifically designed for the cloud, offered by thousands of third-party vendors (2024). We queried these marketplaces for mentions of [AI] to examine what kind of AI apps are being built on top of cloud infrastructure.

The Appification of AI

Examining the AI app ecosystem across different platforms reveals a complex interplay of dependencies and infrastructures underpinning the appification of AI. Preliminary findings suggest a nuanced integration of AI capabilities into apps, highlighting the transformation of AI from backend infrastructure to frontend user-facing applications. While many of the apps in our dataset mention the use of specific AI technologies and models, not all of these could be located. This requires further investigation into 'bespoke' infrastructure entities such as the mention of model names in the code of the apps. The uptake of custom GPTs further exemplifies the appification of AI, showcasing AI's evolution from backend technology to user-facing applications focused on skills, instructions, and knowledge.

Furthermore, AI infrastructure heavily depends on cloud services, a fact evident not only in AI apps available in app stores but also in AI-related apps featured in cloud platform marketplaces. These marketplaces serve a critical function by offering apps that effectively connect infrastructure technology with the specific requirements of individuals and organisations across diverse industries.

In conclusion, the appification of AI, spanning multiple platforms, reflects both the ongoing efforts of developers and enterprises to embed AI technologies into everyday life through various apps, as well as the infrastructural ambitions of AI companies in shaping the digital landscape.

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