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Studying the Live Cross-Platform Circulation of Images With Computer Vision API: An Experiment Based on a Sports Media Event

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This article proposes a novel digital methods approach for studying the cross-platform circulation of images, taking these as traffic tags connecting topics across platforms and the open Web. To that end, it makes use of a computer vision API (Google Cloud Vision) to perform automated content-based image searches. The method is experimented on with an analysis of the circulation of pictures shared on Twitter during the 2018 FIFA World Cup Final Draw ceremony. The proposed approach showed high potential for overcoming linguistic and geographical barriers in Internet research by its use of nonverbal objects for cross-linking online content. Moreover, the analysis of the results raised important questions about the opacity of the employed API mechanisms and the limitations imposed by platformization processes for cross-platform endeavors, calling for continued reflexivity in derived studies.

Keywords: digital methods, cross-platform, computer vision, media event

Understanding the cross-platform circulation of Web content is one of the current challenges of digital methods research (Rogers, 2018). Although most studies still focus on specific sociotechnical practices enacted within social media platforms such as Facebook or Twitter, some methodological proposals and empirical studies (e.g., Burgess & Matamoros-Fernández, 2016) have taken hashtags, likes, and/or URLs as traffic tags (Elmer & Langlois, 2013) that organize online activity across different platforms.

Considering the growing "ubiquity of the visual" (Highfield & Leaver, 2016, p. 49) as well as contemporary developments of computer vision technologies, in this study we devise a novel experimental

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approach for using static images to trace how content related to a topic of interest circulate on the Web. This goal is experimentally pursued by tracking the cross-platform circulation of pictures related to the 2018 FIFA World Cup Final Draw ceremony held in Moscow on December 1, 2017. This "deeply-mediatized media event" (Couldry & Hepp, 2018) was broadcast to 203 countries worldwide and, as expected, the performance of its translinguistic audience had a large visibility on social media, especially on Twitter. The employed methodological protocol is based on a commercial cloud-based computer vision tool (Google Cloud Vision API), and the epistemic implications of using such a tool are taken as part of the inquiry itself. Taking inspiration from the "technical fieldwork" proposed by Rieder, Abdulla, Poell, Woltering, and Zack (2015), understood as the detailed observation of technical characteristics and the architecture of a platform, the study asks what analytical opportunities and limitations are afforded by the devised methodological approach and the tools it employs.

In consonance with the transdisciplinary field of science and technologies studies, this experiment integrates a study aiming at a symmetrical approach (Marres & Moats, 2015) to discuss both the cross-platform circulation of images related to a specific media event and the sociotechnical specificities of social media platforms (Dijck, 2013), such as their data-driven computational architectures (especially APIs) and their impact on research built on such mediations. Despite this broader symmetrical aim, however, the experimental nature of the proposed methods has made the empirical case secondary in this article, which will mainly focus on methodological discussions. Concurrently, the "platformization of the Web" (Helmond, 2015, p. 5) has also emerged as a key topic, given the challenges posed by fenced-in architectures of platforms, when compared with open-Web (Plantin, Lagoze, Edwards, & Sandvig, 2016) standards. The data analyzed in this study provide several indications of this matter.

Following this introduction, the second section of the article aims to discuss the grounds on which the proposed methodology is built, putting in relationship Rogers' (2018) proposal of a cross-platform approach and critical API studies (Bucher, 2013), while experimenting with computer vision techniques for visual research. The third section then presents and discusses the novel methodological design hereby proposed. The two-task protocol takes images circulating on Twitter as seeds for the subsequent tracking of their Web and cross-platform circulation over time. The fourth section then develops an analysis of four of the tracked pictures, discussing possible inferences from the acquired data, with a focus on 22 different platform domains and open Web top-level domains (e.g., ".br," ".uk," ".jp"), which were taken as indicators of geographical circulation. In the final section, the methodological limitations and analytical opportunities are discussed considering the empirical findings about both the sports media event and the employed analytical procedures. We primarily find that the proposed methodology shows potential for reaching across linguistic and geographical barriers. Considering the contingent nature of the results, we propose in this article the notion of a horizon of retrievability to name the fuzzy limits to what can be observed through a given retrieval tool or through API-generated data (in this case, Google Cloud Vision API).

Toward Image-Based Cross-Platform Research

Analyzing the social through procedures and techniques based on medium specificities is one of the key contributions of the digital methods approach to Internet research (Rogers, 2015). In the recent past, a wide range of methods and tools have been developed for collecting and analyzing online data; however, most

of the studies focus on the singularities of individual platforms, tending to isolate them from a broader ecology. According to Rogers (2018), this tendency has resulted in a predominance of "API-led studies," revealing not only a dependence on the data provided by each platform but also the consolidation of a perspective of "single-platform studies." Thus, there is a call for methods and procedures for "'uncollapsing' social media," reaching beyond the isolated study of a platform and "develop[ing] techniques for multiple platform analysis that bear medium-sensitivity" (Rogers, 2018, p. 105).

Previously, Elmer and Langlois (2013) asserted that the transition to the Web 2.0-platformed paradigm demanded the overcoming of so-called HTTP methods based on universal protocological entities, such as hyperlinks, as the only interconnecting entity under consideration. As an alternative, the authors suggest strategies for "integrat[ing] user-based experiences and . . . their shared, remixed, and uploaded digital objects into the broader research paradigm" (Elmer & Langlois, 2013, p. 45). To this end, and for understanding the flow of different online activities across different platforms, the authors note the importance of identifying and tracking traffic tags, defined as "operators that allow for the conjunction of multiple modes of organization, of connection of different actors" (Elmer & Langlois, 2013, p. 50). The notion is broad and encompasses any kind of identifiable content that could be tracked on different platforms. Traffic tags could be text phrases, IP addresses, hyperlinks, and ID numbers, among many other uniquely identifiable objects that might be transported and translated to different platforms and formats.

Recent empirical studies and methodological proposals sharing this perspective have thus concentrated their efforts on the analysis of "co-linked, inter-liked and/or cross-hashtagged" content (Rogers, 2018, p. 101) through verbal or alphabetical objects such as keywords, hashtags, or URLs. Burgess and Matamoros-Fernández (2016), for instance, included in their research design the identification of YouTube URLs shared on Twitter with the hashtag #gamergate to map the "network of relations" among videos that were published on the former platform. Similarly, one of the analyses conducted by Driscoll and Thorson (2015) focused on the circulation of videos related to the Occupy movement using "fixed URLs" as keys to integrate "multiplatform" data sets.

Image-centered cross-platform studies are still recent[2] and rare. Pearce et al. (2018) is an exception, which valuably provides centrality to visuals in a cross-platform investigation that describes the overall visual representations of a topic based on each platform's vernacular. The collective research effort led by Farida Vis and Olga Goriunova (2015) is also notable in their consideration of how the tragic photo of Alan Kurdi shifted the debate on the Syrian war and the refugee crisis it ensued. Our study builds on those works, but is distinct in its method and approach, which attempts an image-based querying for the tracking of the broad circulation of particular pictures across different platforms and the open Web at large.

This is a highly significant methodological demand if one considers the increasing centrality of the visual among current online practices. For instance, Highfield and Leaver (2016) point out how this "ubiquity of the visual" (p. 49) has been accompanied and encouraged by platform affordances. The

[2] For a previous experiment, see Issue Animals (https://web.archive.org/web/20190202224944/https://wiki.digitalmethods.net/Dmi/IssueImageAnalysis) ..

centrality of image-based platforms such as YouTube, Instagram, and Snapchat is significant in this matter, as well as the increasing prioritization of visuals on Twitter and Facebook. Likewise, image macros—or "photo-based memes" (Shifman, 2014)—have become conflated with the notion of memes while becoming pivotal in online interaction and in the practices of spreadable media. Additionally, given the nonverbal quality of photographs and illustrations, using them as traffic tags potentially enables research to overcome linguistic barriers, which have been enduring challenges for Internet research.

Computer Vision for Image Search

One of the primary barriers for image-centered approaches in Internet research is the technical challenge of the large-scale processing of images. In this study, this is required for the reverse search of particular pictures, which requires not only a massive indexing of online content but also efficient image-matching techniques. A key issue this task is what is commonly referred to as the "semantic gap" between low-level data representation of an image and high-level interpretations of it. Golan Levin (2006, p. 468) has illustratively referred to this as the computational opacity of the visual, indicating the need for several layers of inference over pixel data to make visual attributes manageable by algorithms. Such processes make up the broad computer sciences' subdiscipline of computer vision, which aims to make the visual attributes of digital images computable. Its developments are important resources for Internet research that takes images as its privileged topic of inquiry,[3] given the volume of visual data typically composing its data sets.

In this study, the overarching challenge of computationally approaching images is restricted to the task of content-based image retrieval (CBIR). Generally, it encompasses any kind of querying for images based on their content (rather than metadata). In this study, we are interested in "target search" (Smeulders, Worring, Santini, Gupta, & Jain, 2000): searching for multiple occurrences of a specific image within a data set. Although being more specific than the broader tasks undertaken by contemporary computer vision, this is nonetheless a complex process. Broadly speaking, it requires the generation of computational descriptions of the queried images, while prioritizing aspects invariant to modifications that should be disregarded according to the needs of the application, such as compression artifacts and some level of editing (e.g., color balance, minor cropping, overlaid content).

Although much of this has been done through the development of expert systems in the early years of the discipline (Smeulders et al., 2000), trends of the past decade point to an increasing reliance on probabilistic machine learning systems, as Wan et al. (2014), among others, illustrate. However, applying CBIR to the Web, as in this study, entails additional challenges for system architecture. Whereas, typically, information retrieval is bound to a stable and contained data set, searching for an image on the Web requires that this data set be a dynamic and growing index of Web pages and images.

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[3] The field of cultural analytics (Manovich, 2016) has been largely devoted to this, particularly in describing large visual data sets in aggregate form.

This type of search has been accomplished by tools such as TinEye or Google's search by image for at least the past decade.[4] Both provide graphic interfaces for finding occurrences of an image (or similar ones) on the Web. Within the context of this study, we resorted to the more recent Google Cloud Vision API, specifically to its Web detection module, which provides a programmable interface to Google's "search by image" function, with a few added features. Having been released in 2015, the API is part of a wave of commercial computer vision APIs released at the time, but its Web detection module is somewhat particular in its providing of CBIR built on the company's widely used crawling and indexing engine.[5]

Google's "massive indexing machine" (Rogers, 2015) has been a cornerstone in the context of digital methods, given the field's premise of reflexively studying natively digital objects by repurposing natively digital devices. This centrality is justified by Google's role as a key agent in the organization and retrieval of content diffused on the Web. Although Google does not provide detailed documentation regarding how the "search by image" or the Web detection module work, they are presumably built on an evolving approach to CBIR, while bounded by the limits of its also evolving general crawling and indexing engine. Thus, whatever we may achieve through Google Cloud Vision API is likely at least as restricted as Google's traditional search engine, with the added complexity of its image-matching mechanisms.

In line with the premises of digital methods (Rogers, 2015), it is crucial not to take Google's centrality within the culture of Internet users as if totalizing: Google's results are not the Web. Rather, it is necessary to acknowledge its mediatory condition. Paraphrasing Bucher's (2013) characterization of Twitter's API, Google is not simply an intermediary between its users and the Web, it transforms and shapes them both. Importantly, Google's indexing is not only incomplete, but it is also business oriented (Rieder & Sire, 2013), which inflicts a particular bias to the results that cannot be ignored. Google's indexing machine should thus be understood as a "historical contingent [arrangement] of social and material components that coalesce to produce new realities" (Bucher, 2013, p. 1). In this sense, our use of Google's API to retrieve Web occurrences of images is bound by an abstract and relativistic notion we refer to as a "horizon of retrievability." We use this term to refer to the fuzzy limits of what is easier or more difficult to retrieve from the Web through particular search mechanisms and within a particular and contingent circumstance, whether the content is available online or not. It thus sets the diffuse limits of our inquiry, embedded as it is within the contingent and opaque mediation of Google's engine.

A Methodological Design for Studying a Sports Media Event

To discuss both the cross-platform circulation of images and an experimental digital methods approach for its study, this study's empirical component is based on the 2018 FIFA World Cup Final Draw

[4] TinEye was released by the Canadian company Idée in 2008 (see https://web.archive.org/web/20160914171724/https://tineye.com/press/archived_news). Google's "search by image" feature was released in 2011 (see https://web.archive.org/web/20180129140614/https://techcrunch.com/2011/06/14/google-search-by-image-use-a-snapshot-as-your-search-query/).

[5] Similar API-based reverse image search products are provided by Microsoft and TinEye. Pixsy also provides a similar product aimed at monitoring copyright infringement.

ceremony, which took place in Moscow, Russia, on December 1, 2017. Already a traditional event in preparation for the quadrennial tournament, it is when each of the 32 qualified national teams are assigned to a group for the first round of the competition. The ceremony for the 2018 edition was held in the State Kremlin Palace and was attended by former and current players, coaches, soccer administrators, politicians, and other personalities.

The event's broadcasting to 203 countries worldwide has turned it into more than a simple "bureaucratic procedure" in preparation for the competition. Reflecting on the "live broadcasts of sports," Van Es (2017, p. 1249) highlights the "unpredictability of the competition" as one of the specificities of this kind of media event. If this characteristic applies to the broadcasting of a match, it seems even more evident in the case of a draw, when, by definition, there is no expected outcome, and considering the rules previously set, "anything can happen." This "radical unpredictability" of a draw, we argue, stimulates a singular entanglement between institutions and audiences that can potentially result in a unique dynamic of liveness.

Additionally, more than a regular soccer match that attracts localized audiences, a draw is a "deeply-mediatized media event" (Couldry & Hepp, 2018) that potentially puts a more transnational and translinguistic audience in touch with the proceedings. This deep mediatization is emphasized by the short duration of the ceremony, triggering a singular relationship among Twitter, TV broadcasting (Highfield, Harrington, & Bruns, 2013), and sports media and soccer supporters (Bruns, Weller, & Harrington, 2014). Because of the "'live' performance of mediated sport spectatorship" (Rowe, 2014, p. 357), the media event was highly commented on Twitter, even before its occurrence.[6] Right after the ceremony, eight of the top 10 "worldwide trend topics" were terms and hashtags related to the draw.

The ad hoc research design adopted in this study is divided into two main tasks, summarized in Figure 1. The first task's goal was collecting and selecting images to be tracked. To that purpose, we used Twitter as an entry point to the online content related to the event.[7] Taking advantage of the relative openness of Twitter's API (Puschmann & Burgess, 2014), a data set of 395,016 tweets was collected from the Twitter Streaming API using Digital Methods Initiative's Twitter Capture and Analysis Toolset (DMI-TCAT; Borra & Rieder, 2014). This capture was based on a query of 47 terms and hashtags in 17 different languages.[8] Data collection commenced at the start of the event (December 1, 2017, 15:00 UTC) and continued two hours after it ended (December 1, 2017, 18:00 UTC).

[6] See https://web.archive.org/web/20171205140852/https://blog.twitter.com/official/en_us/topics/events/2017/WorldCupDraw-conversation-is-happening-on-Twitter.html

[7] Because Twitter is taken here as a means for the live access to seed images relevant to the case, we will not delve deeper into this platform's cultures of use or affordances, although these are certainly important factors to consider in further applications of the proposed methodology.

[8] The hashtags were identified on Twitter and on specialized news outlets in anticipation of the event. Consults with native speakers of some languages were also sought, prioritizing the languages of the countries taking part in the tournament.

At different stages during the data collection period (15:20, 16:00, 16:30, 17:00, and 18:00), we extracted a list of the 100 most shared "media uploads" using DMI-TCAT's built-in analytical function. After the second iteration, the list was combined with data from previous rankings so as to continue to retrieve information for items that could have dropped from the top of the rankings. At the end of this process, at 18:00, the cumulative list was composed of 219 media URLs shared on Twitter.

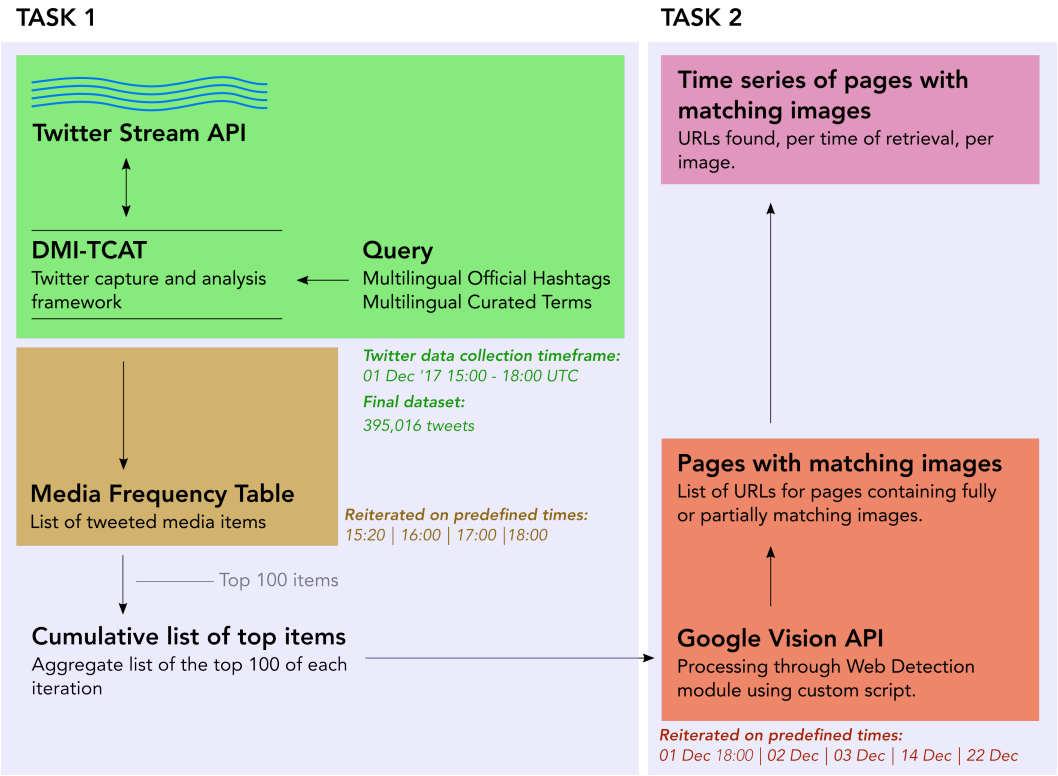

Figure 1. Diagram of methodological protocol for data collection/analysis.

For the second methodological task, the obtained media URL list was submitted to Google Cloud Vision API's Web Detection module using a custom script.[9] This was done at five moments: at 18:00 on December 1 and at 12:00 on four later occasions, on December 2, 3, 14, and 22. Through this process, we collected a time series of URL lists pointing to pages at which—at each moment—Google's engine was able to index images that it considered "fully" or "partially" matching those collected from Twitter.[10]

[9] Derived from Rieder, Den Tex, and Mintz's (2018) Memespector script.

[10] Although no limit was explicitly established by the API's documentation, the maximum amount of URLs retrieved for a given image was of 951, even though we had set the maximum results limit to 10,000.

The next step was selecting the images that would be used to analyze their cross-platform circulation. We chose a subset of four pictures in a tentative approach based mostly on their popularity, their potential for circulating among diverse audiences, and the possibility of making comparisons among them (see Figure 2). A manual analysis revealed that three of these images were posted by more than one "original" tweet (as opposed to retweets), because different URLs in the cumulative list pointed to the same content.[11] Thus, the different media URLs were grouped for the analysis as referring to the same picture.

Figure 2. Pictures selected from the data set for analysis.

Two of the four selected pictures are backstage photos that portray renowned veteran Brazilian player Pelé using a wheelchair, surrounded by fellow sportsmen, politicians, and authorities. One of these (henceforth referred to as Picture A) is an amateur-looking snapshot posted by former Brazilian player Cafu on his personal Twitter account (@officialcafu) at 14:30, 30 minutes before the ceremony. It had strong and longstanding retweeting dynamics, performing as the most frequent media item from 15:00 to 17:00. Six other URLs among the list of 219 also pointed to this picture, posted in tweets by other profiles. In total, until 18:00, this group of tweets containing the picture was retweeted 1,890 times.

[11] Each URL indicates an "original" tweet of the picture, whereas retweets do not generate new URLs for the image.

Another backstage photo (Picture B) depicts Pelé with a different entourage, sitting beside Russian president Vladimir Putin and receiving a kiss on the forehead from fellow veteran Argentinian player Maradona. It was tweeted by the official FIFA World Cup profile at 15:23, nearly 30 minutes after it was likely taken. This picture had no other URL pointing to it within the list of media URLs being tracked. Thus, considering only the original tweet, the picture was shared 1,062 times.

The other two pictures are "photo-based memes" (Shifman, 2014) directed at particular national publics. One (Picture C) is an altered image featuring former Italian player Cannavaro showing a piece of paper with the Spanish text "Chile no va" ("Chile won't go"). The shot was originally taken in 2015 when Cannavaro took part in a preliminary draw organized by FIFA, and the word printed on the paper was "Canada," The photomontage was used to tease Chilean soccer fans regarding the team's elimination in the World Cup qualifiers. In total, we were able to find 10 different URLs pointing to his photomontage in our data set. Altogether, these tweets were retweeted 1,802 times.

Finally, the fourth picture (Picture D) is a meme that refers to the Arabic derby between Egypt and Saudi Arabia, which was defined by the draw. The word the Egyptian man is yelling has two meanings: "I was pushed" and "Kabsa" (a famous Saudi rice dish). Playing on the double meaning, the Saudi answers "tasty," ironically dismissing the Egyptian's foul claim. This meme appears in the list of tracked media URLs nearly 30 minutes after the end of the event, and two of those 219 URLs pointed to this picture, totaling 1,224 retweets. In total, the four selected pictures appeared in 5,978 of the collected tweets.

Analysis: Tracking Cross-Platform and Web Circulation

The analysis of the selected pictures' circulation dynamics focused on mapping their incidence on social media platforms and on the open Web, whose indicators were extracted from the URLs of the pages in which matching images were found. Using custom Python scripts,[12] the URLs were broken down according to their particular syntax into some of their meaningful parts, extracting domains and top-level domains (TLD). These two elements are the base of the analytical efforts presented in this section: one taking the domains as identifiers of social media platforms, and another taking TLDs as markers of geographical incidence. For both of these approaches, stream graphs were central analytical devices, providing insights into the number of occurrences in different platforms and to the circulation patterns for each image, approached comparatively. The graphs depict the number of pages found within each domain or TLD, as well as the change in these occurrences over time. Despite this quantitative aspect of the graphs, our approach to them is mostly comparative and qualitative, in the sense that we try to interpret them as indices of the circulation dynamics and of the data obtained through Google Cloud Vision API.

[12] The scripts used the Python module tldextract (Kurkowski, 2018).

Social Media Platform Occurrences

In a first analytical effort, the domains were taken as identifiers of social media platforms, which we categorized using a list of 22 domains, consolidated from four listings published in 2017.[13] Occurrences of the tracked images were found in 11 of the domains (see Table 1).

Table 1. List of Social Media Platforms in Which Occurrences of the Tracked Images Were Found.

SM platform	Domain host name	Occurring pics.				Chart colors
Facebook	facebook [.com]	A	B	C	D	
YouTube	youtube [.com]	A		C	D	
Twitter	twitter [.com]	A	B	C	D	
Reddit	reddit [.com]		B	C	D	
Pinterest	pinterest [various]	A	B	C		
Tumblr	tumblr [.com]			C		
Google+	plus.google [.com]			C	D	
VKontakte	vk [.com]	A				
Sina Weibo	weibo [.com/.cn]	A				
Odnoklassniki	ok [.ru]	A	B			
Taringa!	taringa [.net]			C		

[13] The list is the following: Facebook, Google+, Instagram, Odnoklassniki, Pinterest, Reddit, Taringa!, Flickr, Tumblr, LinkedIn, Twitter, Classmates, Meetup, Qzone, VKontakte, Facenama, Netlog/Twoo, Sina Weibo, Renren, Draugiem, Mixi, and YouTube. Listings used as reference are based on monthly and daily active users and of unique monthly users, as well as on regionally relevant platforms (https://web.archive.org/web/20180830021416/http://vincos.it/social-media-statistics/; https://web.archive.org/web/20171207080853/http://www.worldatlas.com/articles/most-popular-social-media-networks-in-the-world.html; https://web.archive.org/web/20190309065024/https://www.dreamgrow.com/top-15-most-popular-social-networking-sites/; https://web.archive.org/web/20181120143840/https://www.lifewire.com/internationally-popular-social-networks-3486037).

Supporting the analysis, Figure 3 contains the stream graphs for occurrences of each of the four selected pictures on social media platforms over time, as well as under "Web" in domains not pertaining to any of those platforms, which are thus related to what we refer to as the open Web. Regarding the latter category, it is important to note that although it collapses a wide diversity of cases, it was deemed necessary in our exploratory approach of the data, mainly because of the different meanings for the URL count between social media platform domains and open Web domains. In the former cases, the centrality of user-generated content leads to the interpretation—mostly valid—that different pages containing the picture would indicate different postings of it by different users, thus suggesting its popularity in that realm. In open Web domains, however, the same does not apply, given that the occurrence count in cases such as news portals only indicate the number of pages in which the image was found, which does not seem to be an indicator of popularity (as in the case of social media platforms), nor of anything that could be generally interpreted for different open Web domains.[14] For example, elpais.com.uy reached a count of 34 pages containing images matching Picture C on December 1, but it was mainly due to multiple occurrences of the picture as a thumbnail preview for one single news article.

An overview of the graphs reveals how the dynamics visualized in most of the graphs can be initially counterintuitive given that the number of occurrences does not grow continuously. With the exception of Picture B, all other graphs show a peak of occurrences on December 14, with a small decrease on December 22. Moreover, Picture C starts off with a larger number of occurrences than the one observed on December 3. Two factors seem to contribute to these observations. First, Google Vision API's Web Detection opaque indexing processes. Second, actual changes in the indexed pages, which can be largely explained by dynamically generated Web pages that feature only recent or trending content. As an example of the latter, many of the Twitter URLs found are not of individual tweets, but of dynamically generated hashtag pages or user profile pages, as will be explored later. This may partially explain the steep decrease of Twitter URLs from Picture A's results.

It is also relevant to note that Twitter, Facebook, and other social media platforms appear significantly late in the listed occurrences, although Twitter had been the platform from which we collected the pictures in the first place. In most cases they only show up in results on December 14, skipping the first three Vision API retrieval iterations. Like the noncumulative growth, this finding indicates that the temporality of this graph is very much dependent of Google's indexing process and to the availability of such data to its indexing machine.

[14] Additionally leading to this understanding was the great fragmentation of data falling within the "Web" category: Although social media platform domains had an average of 28.29 pages found per domain per retrieval iteration, open Web domains had an average of 2.02 pages, with 60.66% of the domains appearing with only one URL.

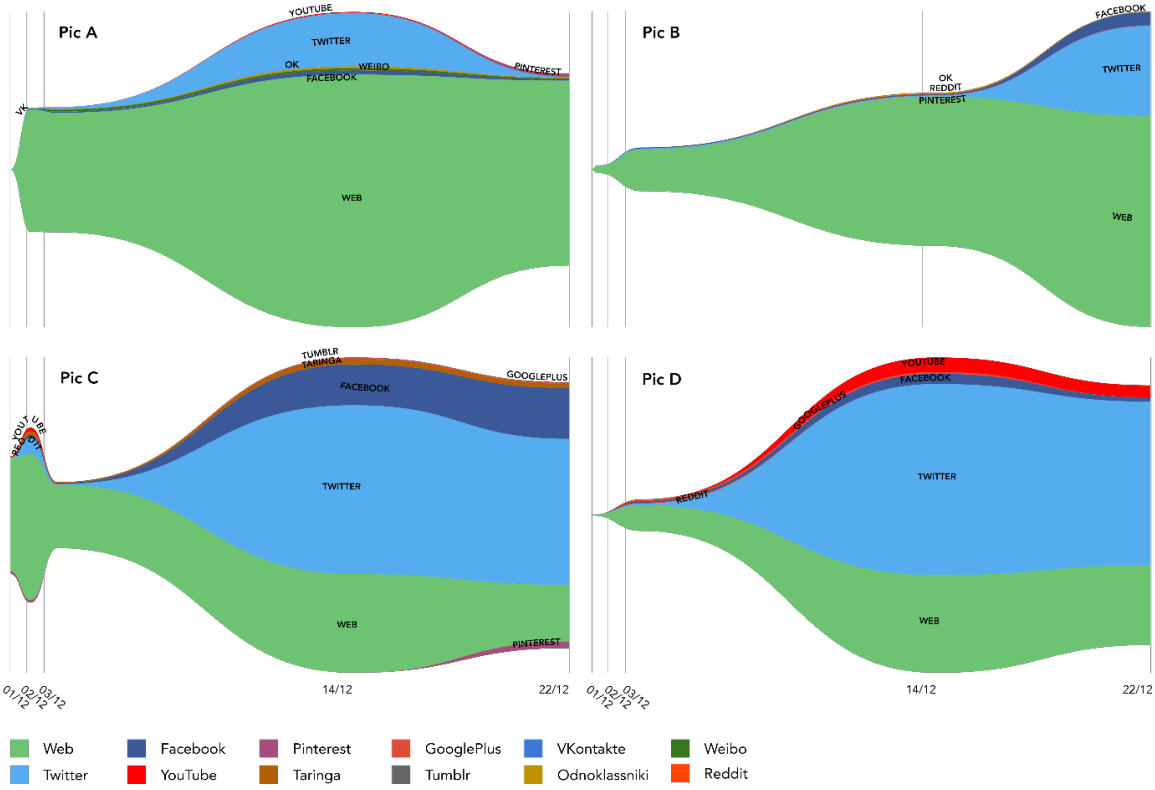

Figure 3. Stream graphs for the URLs of pages with matching images categorized by mainstream platforms over time. In the left–right direction, the top row is relative to Pictures A and B and the bottom row is relative to Pictures C and D. For each graph, the vertical scale has been normalized to the peak number of occurrences. The graphs represent data points of only five moments in time, indicated by the vertical lines, with transition curves extrapolated for the sole purpose of visual readability, but not accounting for actual values between those moments. The graphs were created using RAWGraphs (Mauri, Elli, Caviglia, Uboldi, & Azzi, 2017).

The graphs also show that the tracked occurrences of Pictures A and B are less concentrated on social media platforms than those of Pictures C and D. Most of the former pair's occurrences over time are on open Web pages, and the latter pair of pictures occurs mostly on social media platforms. Apart from Twitter (which, as will be discussed, stands out as the most occurring platform for all pictures), each case shows a slightly different pattern of occurrences within the mapped platforms. Picture A (the backstage photo published by Cafu) shows minor social media occurrences, mostly on Facebook, but also on Pinterest, Odnoklassniki, VKontakte, Sina Weibo, and YouTube. In the case of Picture B (backstage photo posted by FIFA), Facebook stands out after Twitter, and also minor occurrences of Odnoklassniki, Pinterest, and Reddit. For Picture C ("Chile no va" meme), Facebook also stands out, together with smaller occurrences on Taringa! and Pinterest, and smaller still on Google+, Tumblr, YouTube, and Reddit. Finally,

Picture D (Arabic derby meme) has YouTube standing out, and smaller occurrences on Facebook, Google+, and Reddit. As will be discussed in the final section, Instagram is notably absent in the collected data.

The occurrences on particular platforms are telling of the kind of contexts the pictures resonated within. Although it is risky to assume a monolithic public for each platform, it is significant to note that Reddit, for instance, is a forum-based platform, which, contrasting with Twitter, Facebook, or YouTube, is commonly not officially used by institutional players such as media outlets, governments, and FIFA. Thus, a picture's incidence on this platform may be a partial indicator of its sharing by noninstitutional users. Pictures C and D were the only ones with pages found on this platform, respectively on "r/LadyBoners," a community for women to share sexually arousing pictures (mostly of attractive men), and on "r/saudiarabia," a community for sharing memes and news related to Saudi Arabia. It is also interesting that some of these static images were tracked on YouTube, which is a video-hosting platform. By following some of the identified URLs, we found occurrences of the pictures as thumbnails, either of the linked video or of videos indicated as relating to it.

It is still significant that within the obtained results we were able to identify the incidence of regional platforms. This is the case of the Hispanic platform Taringa!, which shows up in the results for Picture C, and which has particular relevance for the Argentine public. Pictures A and B were reproduced on the Russian and Chinese platforms VKontakte, Odnoklassniki, and Sina Weibo, indicating broader international appeal, reaching over to the Eastern hemisphere. These occurrences are particularly relevant, as positive outcomes of the broad scope of the methods employed, which enable reaching out to platform cultures not usually accessible through an individual researcher's cultural or linguistic background and which would go by unnoticed in a platform-specific approach.

The different shares of social media domains and open Web domains among the corpus can be attributed to some specificities implied by Pictures C and D being "photo-based memes." Pictures A and B are photos that document backstage interactions among celebrities participating at the event and are thus possibly considered more editorially adequate than the memetic and regional Pictures C and D. Conversely, with their humoristic tone, these could be said to be more typically identified with social media platforms' user-generated content and sharing cultures, while also appealing more to regional publics.

Still, some differences could be pointed out between A and B regarding their growth dynamics. Picture A shows a large growth of occurrences in the beginning of the tracked period, generating a near-vertical slope, whereas Picture B shows a slower growth of tracked occurrences, making up a more funnel-shaped graph. This seems to correspond to our data collection, which shows Picture A as being significantly more shared than Picture B (1,890 vs. 1,062), topping the rankings for nearly all of our time span. Moreover, although Picture A appeals to soccer fans worldwide given the persons portrayed, Picture B is more directly implicated by the host country's political agenda, given Putin's prominent placement in the composition.

Another remark regarding the exceptionality of the growth dynamics for occurrences of the altered image "Chile no va" (Picture C): Although all other pictures start from zero or near-zero occurrences on the first reverse-search iteration, Picture C starts off with a significant amount of occurrences (355). This is an indicator that pictures partially or even fully matching Picture C were already in circulation before the event and were thus previously indexed. This was expected, given that the picture is a photomontage made by overlaying text onto a found picture of a past mediatized sports media event. Less obvious is the steep decrease of occurrences on December 3, two days after the ceremony, as if the introduction of newer occurrences of the picture had provoked a drastic reconfiguration of Google's indexation. Different dynamics were found for Picture D, despite also being a montage of what seems to be a found picture. In consonance with the fact that the regional derby it refers to was defined by the draw, the data analysis suggests that the montage was created and shared only during the ceremony's broadcast. This would also mean that the original picture composing the meme was not found in this approach, possibly falling beyond the contingent horizon of retrievability of the study.

Top-Level Domain Occurrences

Presenting the second analytical effort, Figure 4 shows stream graphs for each of the four pictures' circulation categorized by the main TLDs found within open Web occurrences. This segment of URL syntax (e.g., ".br," ".uk," or ".jp") was taken as a relevant marker for analyzing the national and regional circulation of the pictures, given that they are commonly attributed according to the website's geographical location. However, considering that most social media platforms make use of ".com" regardless of the location of the users, we chose to focus this effort only on domains not matching those of social media platforms—indicated as pertaining to the open Web—and also as a way of uncollapsing the "Web" category in the previous subsection. Considering that websites may use a TLD not related to their location—particularly nonregional ones such as ".com" and ".net"—we focus special attention on the ones that are attributed to specific geographic contexts.

The comparative analysis of the graphs in Figure 4 reinforces the different circulation dynamics found for each of the four pictures, but now manifests on a different aspect than the previously discussed incidence on social media platforms. The ".com" TLD remains as the most occurring among the four cases, but each of the pictures have very different shares of regional TLDs. Pictures A and B show a larger diversity of national TLDs when compared with Pictures C and particularly D. This seems consistent with the observations previously made about the latter pair's more regional appeal, considering both the language of the texts inscribed in the pictures and the context within which they are meaningful.

Thus, as expected, Picture C ("Chile no va" meme) circulates among various Latin American TLDs, such as the ones related to Mexico (.mx), Argentina (.ar), Chile (.cl), Peru (.pe), Uruguay (.uy), Brazil (.br), Nicaragua (.ni), Colombia (.co), and El Salvador (.sv), among others. Meanwhile, Picture D is exceptionally devoid of national TLDs. Neither Egypt (.eg) nor Saudi Arabia's (.sa) TLDs are found, but nonregional ones are, such as ".net," ".org," ".club," or ".fm" (which, although related to Micronesia, is commonly used by FM radios). However, a quick browse through the Web pages indicated by the URLs reveal that they contain texts in Arabic; therefore, despite the lack of geographical markers on the addresses, they are indeed related to the region.

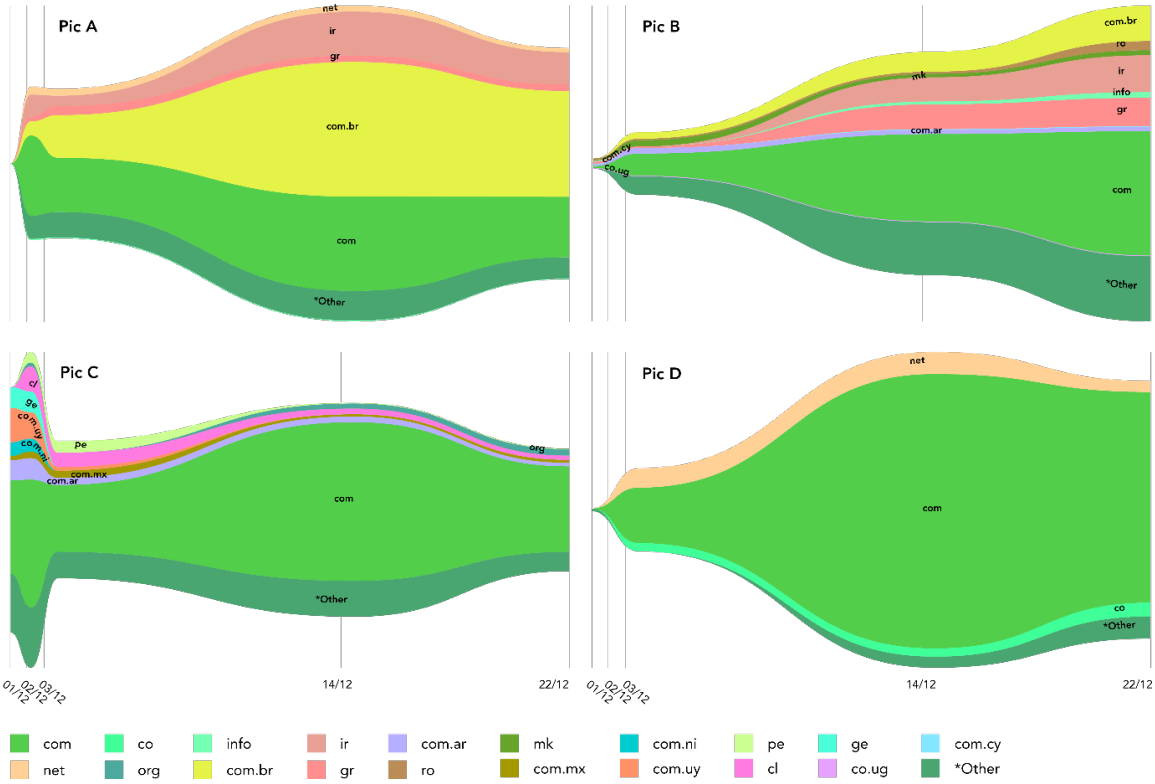

Figure 4. Stream graphs for the URLs of pages with matching images categorized by TLD, over time. In the left–right direction, the top row is relative to Pictures A and B and the bottom row is relative to Pictures C and D. For improving legibility, TLDs that did not reach more than 5% of the occurrences for at least one of the reverse search iterations were grouped in the "Other" category.

Quite differently, Pictures A and B show a more diverse range of TLDs, which also highlights some differences of circulation dynamics among the two. Picture A is an exception among the four pictures, with a majority of the occurrences being concentrated on the Brazilian ".com.br" TDL, which was expected because the picture was tweeted by a former Brazilian player. It is curious, however, that the second highest occurring regional TLD is the Iranian ".ir." Moreover, the large diversity of regions found for this picture seems to indicate the global appeal of the picture[15] that is unmatched by the others.

[15] Some of the other national TLDs found include China (.cn), Bulgaria (.bg), Russia (.ru), Czech Republic (.cz), Greece (.gr), Australia (.au), Poland (.pl), Saudi Arabia (.net.sa), Vietnam (.vn), Argentina (.ar), India (.in), France (.fr), South Korea (.kr), Ukraine (.ua), Venezuela (.ve), United Kingdom (.uk), Azerbaijan (.az), and Hong Kong (.hk).

For Picture B, the highest occurrences of regional TLDs are shared among Brazil (.br), Greece (.gr), and Iran (.ir). Meanwhile, Russia (.ru) and Romania (.ro) also hold a relatively high number of occurrences. Considering TLDs with minor occurrences, the diversity nearly matches that of Picture A, also indicating a global circulation of the picture posted by FIFA. However, some differences are noted concerning a higher occurrence of countries within Russia's sphere of influence, some of which were not identified for Picture A, such as Kazakhstan (.kz), Armenia (.am), Uzbekistan (.uz), and Macedonia (.mk), apart from other countries that were also found for Picture A, such as Ukraine (.uk) and Azerbaijan (.az). Additionally, sub-Saharan African TLDs were identified for Picture B for the countries of Uganda (.ug) and Nigeria (.ng), with the latter likely related to the presence of former Nigerian player "Jay-Jay" Okocha. These particularities seem to indicate the different geopolitical implications of this picture, considering not only the international repercussions of FIFA's diplomatic strategy but also the regional involvement of Russia's political agenda.

Discussion of Findings: Limitations and Potential

The empirical experiment just described provides a meaningful substrate for discussing the specificities of the analytical procedures that were adopted, following a methodological gesture inspired by Rieder et al.'s (2015) "technical fieldwork" proposition. As pointed out in the analysis, several aspects of the data may be attributed to Google Vision API's operation and may thus highlight the issue of its opacity. Some of the most evident of those are the seemingly counterintuitive decrease in the total number of URLs retrieved in some of the iterations, and the late indexation of the selected pictures on social media platforms (including Twitter occurrences). These aspects shed light on Google Vision API's role as an active mediator (Bucher, 2013) in our methodological design, and raise questions about the implications of applying it in this type of research.

For instance, in all cases, Google Cloud Vision API found most of the pictures on Twitter. It is important to consider the relative positioning of different platforms within the contingent horizon of retrievability of our approach. The basic conditions that enable Google to index Web content are the HTTP availability of the content, through publicly available URLs, and Google's bot's ability to crawl through the page's content in the domain's robots exclusion standard file (robots.txt). The total or partial absence of such conditions can, for instance, explain the greater number of occurrences on Twitter than on Facebook. Tweets are not only more commonly publicly accessible—as a default setting of the platform and a culture of use—but the platform is also very permissive regarding its allowing of indexing by external crawlers.[16]

Still, regarding Twitter's prevalence, the pictures were selected because of an already known large occurrence on this platform; thus, it should be expected that they would mostly be found there. To assess the validity of this assumption, we tested the 1,303 unique Twitter URLs retrieved using the Vision API against the URLs for the individual tweets and user profiles of the 5,978 tweets related to the selected pictures. Surprisingly, only 52 (or 4%) of the Twitter URLs retrieved by Google could be directly related to

[16] The Twitter robots.txt file (https://web.archive.org/web/20180815000157/http://twitter.com/robots.txt) allows access to all public tweet and profile URLs.

those tweets collected in the first task of our methodological protocol.[17] A manual verification of the individual tweets returned by Google showed that at least half of them did not feature the terms and hashtags used to collect data from Twitter. This would then indicate that the many Twitter URLs retrieved by Google Cloud Vision API was not only a direct consequence of already known tweets but that the use of this methodology has the potential for circumventing the verbal orientation of querying functions provided by platforms' APIs. This would then reinforce our claim that the proposed nonverbal approach could reach social media posts beyond typical querying by terms and hashtags, expanding, so to speak, the horizon of retrievability of the inquiry.

In the case of Facebook, although pages are available through public URLs as well as Google's crawler, individual user profiles are not, as a password log in is required to access them. Moreover, even though every photo is accessible through public URLs, they are marked as off limits to indexing bots. When found, most Facebook URLs in our data pointed to either the landing page of public pages or to their "photos" section (/[page handle]/photo), both of which are not blocked for crawlers.[18] This hinders the results for Facebook, given that individual user accounts and individual posts, even by public pages, cannot be indexed by Google. As for Instagram, although the platform does allow bot crawlers to access individual profiles, the page's source code masks image URLs by dynamically generating the HTML code displaying it, thus blocking its visibility to bot crawlers. Consequently, no Instagram URLs have been found in our experiment, despite Instagram's popularity. Significantly, the platform's architecture is made impermeable to some cross-platform postings, such as by (since 2012) not allowing Twitter to show thumbnails of Instagram posts.

Therefore, by the way social media platform occurrences were mapped, the data provide an insight into some of the methodological impacts of the increasing "platformization of the Web" (Helmond, 2015). We hypothesize that the small incidence of pictures on Facebook and Instagram, for instance, would be less likely due to an actual small incidence in those platforms than to a diminishing horizon of retrievability of Web-based tools, such as Google's search engine, through processes of platformization. As one of the consequences of its development in the past decade or so, user-generated content has migrated from openly available Web pages to the fenced grounds of social media platforms. Its access has thus been mediated by logins (or APIs) and hence has become individualized and segregated from the WWW and its initial project. Although part of this is justified by concerns over users' privacy, platforms'

[17] The URLs retrieved by Google Vision API pointed to different types of Web pages hosted by the platform. Most of them were user profile pages (87%), followed by hashtag pages (e.g., https://twitter.com/hashtag/russia2018), statuses (individual tweets), and search results (e.g., https://twitter.com/search?q=Russia2018&lang=en). We tested whether URLs pointing to statuses and user pages could be related to tweets and users in our initial data set that shared the elected media's URLs. Given that the same images could have been tweeted with other media URLs falling beyond the top instances in the "media frequency table," we cannot assert exactly how many of the tweets and users retrieved through Google Cloud Vision API were in our original data set; this would require content matching across images in our whole data set.

[18] See https://web.archive.org/web/20180910120036/https://facebook.com/robots.txt, which blocks access to some picture-related paths ("/photo.php," "/photos.php," and "/album.php").

secession from the Web should be noted as establishing a different internal order about the modes of organizing, browsing, and retrieving information. This situation also diminishes the interchange between platforms and the reach of cross-platform social research. However, it does not entirely inhibit such approaches, as our study has shown in its appropriation of some of the traces that could still be retrieved.

These aspects endorse points previously discussed—for instance, about the unstable sociomateriality of APIs (Bucher, 2013)—and require that investigative efforts retain a strong reflexive approach about the very tools and methods employed. However, following Rogers' (2015) considerations on the groundedness of digital methods, the opaque mediation of such tools does not impede us from cautiously making inferences about the circulation dynamics of these pictures, to which the obtained data are still indicators. The required caution involves not taking the data as total representations of the observed processes, constantly calling them into question. Yet the groundedness of this approach lies, among other aspects, on the centrality of Google's search engine for most Western Internet users, which makes it significant to what we refer to as a horizon of retrievability of online content.

Thus, taking such cautions, there are several things to take away from this study's empirical findings, such as the possibility—afforded by the proposed methodology—of going beyond language barriers and mainstream platforms in a cross-platform study. Using CBIR allowed for the observation of highly different contexts of Internet use that are otherwise difficult to reach from researchers' perspectives. The presence of regional social media platforms and the high frequency of some specific TLDs among open Web occurrences can be seen as the most significant examples of the geographical situatedness of the pictures' circulation.

In a broader sense, it is possible that the live sociotechnical construction (Van Es, 2016) of the World Cup Final Draw, as a deeply mediatized media event (Couldry & Hepp, 2018), must be understood in light of the tensions between the global and local appropriation of pictures. Additionally, the sharing of pictures that were produced and circulated either long before the event (in the case of Picture C) or just minutes before it began (in the case of Picture A) indicate how the temporality of a contemporary live media event is not limited to its broadcast version. In this sense, the analyzed pictures not only anticipated the ceremony but also expanded it through cross-platform circulation dynamics.

The outcomes of the investigation, considering the proposed challenge of taking visuals as traffic tags for cross-platform studies, are manifold. For future research, the novel methodology proposed in this article opens several lines of inquiry to choose from, depending on the intended analytical focus. An investigation interested in the controversy generated by or surrounding a particular image could take the URLs of pages containing matching images as entry points to the discussion. In such cases, analysis could proceed through a comparative reading of the texts and the conversations they are linked to, going down to the individual instances (e.g., elpais.com.uy) that we have here solely approached in aggregate form (.uy). Similarly, it would be possible to approach it through an analysis of the co-occurrence of different images, or of images and hashtags, or of images and terms, among other integrations.

Thus, our approach is an attempt to take some of the first steps needed for this type of inquiry, while retaining a high level of reflexivity. To that extent, it is an investigation interested not only in the

dynamics of image circulation but also in the mediation of computing frameworks employed, and in the effects of platformization on its many forms of development.

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