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Digital commons

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Abstract: Commons are holistic social institutions to govern the (re)production of resources, articulated through interrelated legal, socio-cultural, economic and institutional dimensions. They represent a comprehensive and radical approach to organise collective action, placing it "beyond market and state" (Bollier & Helfrich, 2012). They form a third way of organising society and the economy that differs from both market-based approaches, with their orientation toward prices, and from bureaucratic forms of organisation, with their orientation toward hierarchies and commands. This governance model has been applied to tangible and intangible resources, to local initiatives (garden, educational material), and to resources governed by global politics (climate, internet infrastructure). Digital commons are a subset of the commons, where the resources are data, information, culture and knowledge which are created and/or maintained online. The notion of the digital commons is an important concept for countering legal enclosure and fostering equitable access to these resources. This article presents the history of the movement of the digital commons, from free software, free culture, and public domain works, to open data and open access to science. It then analyses its foundational dimensions (licensing, authorship, peer production, governance) and finally studies newer forms of the digital commons, urban democratic participation and data commons.

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Introduction

Commons are holistic social institutions for governing the (re)production of resources. They represent a comprehensive and radical approach to organise collective action, placing it "beyond market and state" (Bollier & Helfrich, 2012). As De Angelis (2017, p. 10) put it, they are characterised by "a plurality of people (a community) sharing resources and governing them and their own relations and (re)production processes through horizontal doing in common, commoning". Thus, they form a third way of organising society and the economy that differs from both market-based approaches with their orientation toward prices, and from bureaucratic forms of organisation with their orientation toward hierarchies and commands.

The model has been applied to tangible and intangible resources, to local initiatives (e.g., a shared garden, educational material created by a school) and to resources governed by global politics (e.g., climate, internet infrastructure).

In our proposed definition (see also Stalder, 2010), the digital commons are a subset of the commons, where the resources are data, information, culture and knowledge which are created and/or maintained online. They are shared in ways that avoid their enclosure and allow everyone to access and build upon them. The notion of the digital commons lies at the heart of digital rights, the political fight to expand, rather than restrict, access to information, culture and knowledge (Kapczynski & Krikorian, 2010). Unlike tangible commons (such as urban gardens, forests or meadows), the digital commons (such as free software or Wikipedia) are not affected by overuse or material exclusivity. However, their existence can still be threatened by undersupply, inadequate legal frameworks, pollution, lack of quality or findability.

The traditional and the digital commons provide a socially progressive alternative to producing and sharing resources and to organising collective action across a wide range of domains, with a focus on sustainability and democracy. While not all resources can or should be governed as commons, we claim that this approach can provide political inspiration beyond the digital domain where it is currently applied, with a potential to improve life by expanding access to resources and creating new areas of collective self-governance, at a global and local levels both of-

fline and online.

In the following, we focus on the holistic character of the digital commons as an approach to governance, that is, how their economic, social, legal and cultural dimensions relate to one another in contrast to both market and public provision of resources. We highlight how fundamental an alternative the commons can be, particularly in relation with current issues of capitalism with data-driven surveillance, platform monopolies and the increasingly authoritarian orientation of even many democracies.

We begin with a short history of the commons and the differences between traditional and digital commons. We then introduce the main fields where the digital commons emerged historically (free software, free culture, cultural heritage, science, data and public sector information). We then adopt disciplinary perspectives to analyse each one of the four dimensions which shape each other and together constitute the commons. Digital commons rely on open licensing rules and we study **legal** models preserving sharing and access, which constitute the originality of the digital commons compared to standard copyright used by firms focusing on exclusivity. We then study **cultural** models, which have an impact on authorship and creativity, leading to original **economic** peer production models, the third pillar of commons studied holistically. Last, these three holistic dimensions depend on **governance** by communities, presented as a fourth overarching dimension.

To conclude, we observe emerging fields where the digital commons become a highly relevant model to produce alternatives to both centralised-controlled state politics and surveillance capitalism, towards autonomy and control. In a final section, we analyse examples of platforms enabling decentralised participation for citizens, and sovereignty about personal data.

From traditional to digital commons

Commons have existed across cultures as crucial institutions of traditional, rural communal life (Ostrom, 1990). Through the process of enclosure, which started in the 13th century in England, most of the common land was turned into private property and thus removed from communal use (Linebaugh, 2008). While some traditional commons in remote areas have survived (Nanchen & Borgeat, 2015), they have long been marginalised in theory and in social practice.

In recent years, the theory and practice of commons and commoning have made a remarkable return, highlighted by the Nobel Memorial Prize awarded to Elinor Os-

trom in 2009. Ostrom (1990) identified across a large number of case studies institutional features and governance factors that allow the flourishing of commons. Initially, this perspective had been formulated with regard to traditional common pool resources (such as fisheries, meadows, etc.), but since then the framework has been applied to knowledge commons (Hess & Ostrom, 2007) and to digital commons (Frischmann, Madison & Strandburg, 2014).

There are three main factors that contribute to an increased interest in the commons. First, the ecological crisis creates high urgency to develop alternatives to economic growth and new modes of managing natural resources. This led not only to renewed interest in traditional local commons, but also to conceiving new "global commons" such as the atmosphere or the oceans (pioneered by International Union for Conservation of Nature and Natural Resources et al., 1980). The digital commons are part of both this problem—since internet infrastructure and consumer electronics needed for the production of digital resources, being commons or not, carry a large environmental cost—and the solution. Its governance model can serve as inspiration, thus contributing to the development of alternatives elsewhere (Rifkin, 2014) .

Second, the accumulation of negative effects of untethered commodification and marketisation in the wake of neoliberal policies (particularly social exclusion and inequality) have spurred a broad search of innovative alternatives to austerity, particularly in urban areas (Borch & Kornberger, 2015).

Third, on the internet, new digital commons were emerging from several sources and social contexts, dealing with a wide range of complex knowledge and information resources (Benkler, 2006; Bollier, 2009). Newly developed community-based production models were effectively countering the negative externalities of capitalism on intangible resources, such as enclosure and commodification of knowledge.

The new paradigm of producing informational goods as commons emerged first in the field of software development. In 1984, the programmer Richard M. Stallman founded the free software movement to counter the rise of proprietary software and promote " four freedoms" (Stallman, 1996) related to code: 0) the freedom to run the software for any purpose; 1) the freedom to study and change the programme without restrictions; 2) the freedom to distribute copies of the programme; and 3) the freedom to distribute changes of the programme. As FLOSS (Free, Libre and Open Source Software) projects grew and proliferated, it established the practical example that complex, knowledge-intensive informational re-

sources can be managed as commons in Ostrom's sense (Schweik & English, 2012) and that these are stable and reliable over long periods of time capable of competing directly with market-based commodity production (Weber, 2004). Much of the current internet backbone relies on FLOSS (for example, the Domain Name System) and the wide availability and use of open source web servers (first CERN httpd (1990), then Apache (1995) and now also nginx (2004) has played an important role in the spread and rapid innovation of the World Wide Web. By the end of the 1990s, the tension between conventional notions of property (as enshrined in copyright law) and the growing popularity of collaborative cultural practices online (such as remixing and file sharing) rose to the surface and spilled over to the mainstream.

In part as a response to the increasingly aggressive assertion of copyright by the cultural industries suing customers for performing everyday acts online, and in part drawing inspiration from the free software movement, the free culture (or open content) movement began to take shape (Boyle, 1997; Lessig, 2001). The largest free culture project is Wikipedia, an encyclopedia that is cooperatively written and financed by donations from the readers who are part of the community (Dobusch & Kapeller, 2018). Since the project started in 2001, it has become the most popular and comprehensive global reference source, with 25 billion page views, across its more than 150 language versions and its various sister projects (in June 2020). Other online creation communities can also be governed as digital commons, such as photos shared on Flickr (Fuster Morell, 2010).

GLAM stands for Galleries, Libraries, Archives and Museums, a community of digital commons advocates and projects working to digitise public domain works of our cultural heritage without unnecessary legal (Mazzone, 2011), economic, or technical restrictions to their access and reuse by the public. The public domain comprises creative works to which copyright no longer applies, because it has expired, expressly been waived, or may be inapplicable (Dusollier, 2010). While the public domain is legally and conceptually separate from the digital commons, in practice, public domain works constitute an important source from which commoning practices can draw, all the more as public domain books and artworks are being digitised (Boyle, 2008; Dulong de Rosnay & De Martin, 2012). Public domain in its strict legal meaning happens after the term of copyright, about 70 years after the death of the author. However, some libraries and museums decide, through contractual terms of use of their websites, to reserve some rights to reuse digitised reproductions of the public domain works they preserved, while others (such as within the Europeana consortium) release them under public domain conditions

without any restriction to reuse, or may even collaborate with Wikipedia (see projects of the Glam-Wiki initiative) to release high-quality resolution reproductions directly in the Wikimedia Commons repository (Dulong de Rosnay, 2011).

Another genre of works that are increasingly part of the digital commons are scientific articles and books (Suber, 2016). Largely funded by external sources, it is economically sustainable to dedicate science to the commons. However, a large part of the written output of research is still enclosed in journals controlled by private publishers, commodifying the free labour of publicly-paid researchers and selling it to academic libraries. A developing trend since the early 2000s has been the movement for **open access to science**, which relies on three economic models to govern scientific output as commons: the *green* open access model, where authors are authorised by publishers to upload their articles or a pre-print version in open access institutional repositories to make them accessible to the public for free, the *gold* open access model, where articles are directly accessible under free and open conditions, with or without author processing charges depending of the publisher's policy, and finally, the diamond or *platinum* models (Fuchs & Sandoval, 2013; Normand, 2018), where institutions or libraries are financing gold open access journals or books.

The movement for open science and scientific commons encompasses also data. A rationale for open access to scientific data and data reproducibility is that science will work better if other scientists can review, verify, and reuse data from a study (Royal Society, 2012). Also, opening scientific data will ensure it remains available (Vines et al., 2014). Another justification for open science and open data, also valid for state-supported culture, heritage and education, is that their production is already covered by public funds, making the restriction of copyright to remove them from the commons an unnecessary incentive (Suber, 2016). Many legislators or funders have created policies requiring research they sponsor to be released under open access and open data conditions. These are available in the Registry of Open Access Repository Mandates and Policies (ROARMAP). Whether researchers effectively comply with these policies and if they need better enforcement mechanisms remains to be seen (Larivière et al., 2018).

Four dimensions of digital commons

Commons are managed by different socio-economic arrangements than the standard market and state models. They rely on a holistic combination of legal frameworks, transformed practices of authorship, economic models and modes of governance.

In this section, we are going to present the legal, authorship, economic and social models that inform and govern sustainable digital commons.

While there are many commonalities between digital and the tangible commons, one of the fundamental differences between them is that in the former, the resource is by and large, non-rival. There is no danger of overuse. Therefore, the boundaries (to reuse Ostrom's 1990 terminology) of the community for the digital commons tend to be drawn loosely. Everyone who adheres to the relevant governing rules, for example, the conditions of use prescribed in a licence, is allowed to use the resource and thus can be regarded as part of the community at large. In other words, producers and users are not separated. Like tangible commons, digital commons are in need of ongoing maintenance. They face a danger of pollution, degrading its quality (such as vandalism or the inclusion of wrong facts in Wikipedia pages) or destroying it altogether, and of underproduction and thus need to be curated, sustained and preserved through governance and participation rules.

Law and licencing

Western, liberal law in general is oriented towards creating individual rights, protecting private property and enabling market exchanges (Söderberg, 2002; Capra & Mattei, 2015; Dulong de Rosnay, 2016). It was not designed to support commons and thus can be inadequate to regulate the digital commons, where community, shared resources and non-market relationships are central. The liberal conception of intellectual property, a legal fiction, aimed at implementing this model to regulate intangible creations (Hettinger, 1989; Dutfield & Suthersanen, 2004). For creative works such as text or music, copyright law has been designed to protect individual property by granting original authorship. Derived from that, comes the claim to individual ownership and the right to produce, the control of distribution by the cultural industry and the use of the works by the public and subsequent authors. Only works which are no longer covered by copyright are free to use (Lessig, 2001; Boyle, 2008).

The legal mechanisms of the digital commons have a completely different philosophy, because instead of focusing on providing an economic incentive or reward to individual creators to share by restricting the rights of the public, they aim at preserving copyrightable works against private enclosure, allowing access to knowledge for all (Kapczynski & Krikorian, 2010). This allows for creative production and transformation processes being led by future, unidentified peers and groups. Private instruments (Elkin-Koren, 2005; Dusollier, 2007), in the form of free and open

licences or contracts with the public, have been designed to counter the automatic assignment of exclusive rights to initial authors by copyright laws, and offer more rights to the public than copyright rules applied by default. After free and open licensing was developed originally to support the collaborative development of software (Berry, 2008), a large number of open licensing schemes have been designed to support the development of the digital commons for cultural and scientific works (Guadamuz, 2006), as well as data and databases. While any free and open licence guarantees everybody the rights to use, transform and share a resource, some provide this right unconditionally, others reserve the rights of commercial exploitation, and some require the users to put all derivative works under the same licence in order to preserve the freedoms for subsequent users. The latter are called "copyleft" licences and meant to support creative generativity and avoid private enclosures.

The General Public License (GPL) is the first and most well-known copyleft licence for free software. Its creators, the computer scientist Richard Stallman and the lawyer Eben Moglen, devised the concept of "copyleft" to counter copyright: software licenced under the GPL licence will carry the four freedoms mentioned above.

Creative Commons (CC) licences are the most prominent licencing scheme transposing this model to non-software works such as text, music, images and videos. Creative Commons licences are private governance tools (Elkin-Koren, 2005) to manage the bundle of rights granted by copyright to authors, such as the right of reproduction, of commercial exploitation, of modification, of exclusion and alienation (Dulong de Rosnay, 2016). While all require attribution and allow for the non-commercial sharing of works, not all of them allow for modification of works, and only a couple include a copyleft ("share alike") clause. One variant called CC0 allows one to voluntarily dedicate a work or a database to the public domain, renouncing copyright as much as legally possible. Another CC instrument, the Public Domain mark, allows expert institutions to identify works which already are in the public domain, such as cultural heritage.

While the issue of adapting individual legal culture of property to community rights has been solved by copyleft and open licensing options, some other legal and governance questions have not been addressed by licensing instruments (Elkin-Koren, 2006; Chen, 2009). The wish to accommodate different models of openness and national legal frameworks prompted the development of many different options, leading to legal issues. Some licensing options make different digital commons incompatible (Katz, 2005) with each other. And, more problematic for

the legal sustainability of digital commons, the issue of legal responsibility, in case of copyright violation, has been left out of scope of open licensing, which could create substantial complications for digital commons sustainability and deter institutions from re-using them in their own works. Indeed, if works are distributed without liability by the original licensor, and may contain copyright infringement, institutions could refrain from using such works in order to avoid legal risks. While the digital commons recognise collaborative authorship modes as presented in the next section— and support a vision of incremental building of a collective, shared culture based on public domain works as cultural commons—their legal instruments are still based on liberal legal culture and fail at acknowledging the contribution and the appropriation of non-Western, indigenous cultures and works of folklore (Chen, 2011) into global commons.

Authorship

The alternative legal framework is complemented by a transformation in the notions and practices of creativity. Conventionally, liberal theory conceived creativity as the capacity of the individual exercised in isolation by an unusually gifted person, the (white male) genius (Woodmansee, 1984). Many cultural tropes, from the writer struggling with the empty page, to the artist secluded in her atelier, and the inventor with his personal "eureka" moment, reflect and popularise this notion. This model of the creative process underlies copyright and justifies to attribute a creative work to a single person and afford him (and only much later, her) sole ownership of the work, which is seen as an "original", that this, as something new, a beginning without precedence. While this notion has long dominated the cultural field and the public imagination, for complex knowledge-intensive goods this was never seen as adequate. In 1942, Robert K. Merton (1973, p. 273), defined "communism", understood as "common ownership of goods [as] a[n] … integral element of the scientific ethos", because "the substantive findings of science are a product of social collaboration and are assigned to the community".

Since the late 1960s, postmodern literary theories, using notions such as intertextuality, started to question ideas of individual authorship and reveal the collective dimension of literary work (Woodmansee, 1992). While these theories remained confined to relatively specialised audiences for a long time, they started to resonate with the experience within digital networks (Turkle, 1995) where collaboration and transformation of third party works were technically supported and culturally accepted. The free software movement started out as a cultural revolt in which the encroachment of intellectual property was seen as threatening long-held values of community and cooperation (Stallman, 1985). Within networked

culture more implicitly and the commons more explicitly, creativity is understood less as the faculty of an individual genius, and more as a balance between individual contribution and collective enablement (Stalder, 2018). This points to a more comprehensive transformation of subjectivity, away from standard liberal notions starting from, and centering around, the individual—separate from his or her environment—to different configurations that some started to call "networked individualism" through which the collective (the network) and the singular (the individual) are co-constituted (Nyiri, 2005; Rainie & Wellman, 2012). All of this rubs against notions of individual authorship which are deeply rooted in Western countries, both legally and culturally. It indicates the depths of the challenge that the commons poses to the framework of Western modernity.

Economics, new models of production

In "Tragedy of the Commons", Hardin (1968) famously claimed that resources not managed as private (or state) property were subject to overuse by individual, profit-maximising economic actors. Ostrom (1990) successfully refuted this idea by showing that commons as economic institutions provide successful, long-term alternatives to both market and state-oriented approaches to the (re)production of resources. Since these institutions emerge from local self-organisation, their variability is high and Ostrom deliberately never tried to distill a universal "model" from them, but focussed on a number of "design principles" (McGinnis & Ostrom, 1992), ranging from the definition of boundaries around the resource and the community, the design conflict resolution mechanism to the recognition of the rights of the commons by external actors, which are designated by governance rules in the next section.

Even Hardin (1994) eventually acknowledged that the tragedy of the commons only applies to "unmanaged commons", by which he meant simple open access resources with no use constraints. Of course, such resources are not commons, because it is the shared management that makes a resource a commons. For the same reasons distinct from commons are public goods, usually defined as goods that are non-excludable and non-rivalrous such as a lighthouse (Coase, 1974) or national defense. The resulting free-rider problem makes them unattractive for market players and hence it is often regarded as a function of the state to provide them.

It was Benkler (2002, p. 369) who, focusing on the digital commons, postulated the emergence of a new mode of production, which he called commons-based peer production: "Its central characteristic is that groups of individuals successfully col-

laborate on large-scale projects following a diverse cluster of motivational drives and social signals, rather than either market prices or managerial commands". Benkler noted that this new mode of production emerged at the centre of the most advanced knowledge industry (e.g., software development), largely to its superior way of assigning human resources (self-selection) allowing to draw on motivations and skills that could neither be organised by top-down management nor captured by price signals.

Initially, commons-based peer production was widely seen as a fundamental alternative to the market (Benkler, 2002). Today, only the more radical approaches still pursue this line of inquiry (e.g., Vercellone, 2015; Morozov, 2019). For more mainstream economists, the relationship between commons-based and market-oriented production has become more central, as many commercial firms both contribute to the digital commons and are using Common Pool Resources in their commercial strategies (Sadi et al., 2015). The aim is to develop "open strategies", which is integrating commons-based production and various kinds of crowd-based inputs into company management (Birkinshaw, 2017).

However, without strong approaches to govern the appropriation from the digital commons, it is not certain that large companies benefiting from it will contribute back. The sharing economy, while initially also working with notions of non-market exchange (for example, couch-surfing used to be a non-commercial community platform (Schöpf, 2015)), has been overtaken by capitalist approaches redefined "sharing" as short-term rental of granular resources (such as a room in an apartment, a taxi ride and so on) and has lost all relation to the commons (Slee, 2015).

Governance of digital commons

Governance issues were at the heart of the Ostromian perspective on the commons and the aforementioned eight design principles (Ostrom, 1990; McGinnis & Ostrom, 1992) are, in essence, challenges of governance that need to be solved by communities for a commons to survive as a social institution.

A body of scholarship on the digital commons is aiming at adapting Ostromian governance design principles to the specifics of the intangible, online knowledge economy (Hess & Ostrom, 2007; Schweik & English, 2012; Dulong de Rosnay & Le Crosnier, 2012; Frischmann, Madison, & Sandburg, 2014; Bollier & Helfrich, 2015). Using the same methodology than for traditional commons, these authors' methodology relies on case studies of communities, as they try to observe specificities which might serve as lessons to better govern other digital commons.

In the context of the digital commons, **community boundaries** are constituted not only by producers, but also by potential users. A licence based on opening copyright will define and allocate rights of access and reuse, the digital equivalent of inclusion and exclusion of the community for tangible commons. The challenge for the digital commons, rather than the exhaustion of finite resources, is not only to ensure the availability of the digital resource for all to use while avoiding their exclusive appropriation. Governance of open source software as commons includes the definition of legal constraints (O'Mahony, 2003). Communities can also develop guidelines and procedures to fight against pollution, or to protect information quality, like in the case of the Wikimedia community acting against disinformation (Saez-Trumper, 2019).

But communities, even when they have explicit boundaries, are not legal entities. Surprisingly, in Ostromian institutional analysis, this plays almost no role. Yet, to overcome this limitation many digital commons have created their own foundations as "boundary organisations" (O'Mahony & Bechky, 2008) capable of performing legal, financial, technological and governance services that the community itself cannot provide. Foundations play an important role in the governance of the commons, often leading to an explicit division of labour between community volunteers and foundation staff with a professionalisation of certain functions (Fuster Morell, 2011). Today, most large digital commons are governed by a hybrid community-foundation structure.

As for **participation and social norms** of digital commons communities, they should also focus on fostering the participation of volunteers to various aspects of the production of and caring for the digital commons resources. If the tasks are too difficult, or if the culture is not inclusive, the project will not be sustainable or representative of a diversity of points of views.

Digital commons, particularly in the usually highly structured and often explicitly hierarchical projects, are giving greater centrality to some people seen as contributing more significantly to the shared resource than others (O'Neil, 2009). This can go as far as awarding the core figure (often the founder) the status of "benevolent dictator". The dictatorial powers are, in fact, sharply limited, because the communities are voluntary and there is no exclusivity over the digital resource. Leadership and decision-making can be more or less open (De Noni, Ganzaroli, & Orsi, 2011). The centralisation around one individual will endanger the project in case of departure of the core contributor. However, even within stable and well-functioning digital commons, significant governance challenges remain, such as the potentially inefficient nature of large-scale participatory processes (Jemielniak,

2016) and the persistent underrepresentation of women and people of colour (Dunbar-Hester, 2020).

Decision-making should be participatory and digital platforms can help digital commons communities to coordinate, trace debates and reach consensus. Collective democratic participation in the drafting of the rules is deemed to ensure a higher respect of those rules by the community, if they designed them. For digital commons, framing shared values, such as supporting a non-commercial culture, can help to develop those commons rules. There are different political understandings of commons and as such, there are different approaches on how to govern digital commons as "open" resources and on the degree of openness to choose.

This is also visible in the open government data sector, where the notion of openness (Tkacz, 2012) will vary according to different trends “across the political spectrum” (Bates, 2012, n.p.). This political choice will influence the governance of data and statistics generated or collected by public institutions, by citizens using those public services, or by public procurement services and applications developed by commercial actors.

On the one hand, according to the more libertarian wing of the open data movement, public sector information must be placed under licences which do not impose any legal friction or restrictions on downstream reusers, even commercial ones, in order to foster innovation and growth (Gray, 2014). Open government data will then be made available in conditions as close as possible to the public domain. On the other hand, the more socially-oriented models of the commons (Broumas, 2017) are proposing to retain some rights for the public by favouring copyleft licensing and develop other policies to preserve the digital commons and avoid private appropriation and commodification without a return to the community, the state or the general public.

Depending on the **political values**, projects, citizens and municipalities will make different decisions to govern, for instance, user data about public transportation as digital commons. On the one hand, they can be made available without any legal restriction or prescription, to support all possible downstream innovation and have the market develop numerous apps, including private companies who might not release them under a free licence. On the other hand, municipalities and citizens can choose to not release public transport data in the public domain, or to mandate public procurement transport apps which would reuse this data to release their product as free software. The degree of reciprocity of the appropriability regime has been a feature observed in open source software communities (De

Noni, Ganzaroli, & Orsi, 2011).

Within the communities governing both tangible commons and digital commons, not all tasks should be dedicated to the production and the usage of the resource. Besides activities of caring, community-building, communication and governance, similarly to tangible commons, the **monitoring** of the respect of shared governance rules can translate into roles of quality-control, accountability, moderation or edition. If physical meetings are limited, other arenas to develop trust and conflict resolution have been developed: chatrooms, e-conferences.

And since rules need to be recognised by higher-level authorities and compatible with the **applicable legal frameworks**, legal mechanisms are needed to not only recognise the legitimacy as Ostrom showed, but also to defend the digital commons from enclosure or appropriation. As presented in the next section, current controversies of the digital commons are the capture of public investment to produce open data and of personal data by huge corporations relying on those openly available resources to commodify them.

In order to sustain their activities, digital commons projects can rely on each other: as Ostrom had identified, smaller, local communities need to be embedded, and interact with broader networks, towards a fruitful **ecology of interoperable projects** likely to collaborate, reuse parts and rely on each other, pass the threshold of local micro-initiatives, perhaps develop joint advocacy activities in order to have legal regulation recognise the needs of the digital commons. But **advocacy** led by digital commoners goes beyond purely digital stakes, and communities are nowadays fighting larger struggles than the expansion of intellectual property.

Since 2000, advocates for access to knowledge (Kapczynski & Krikorian, 2010) associated with supporters of the digital commons (formed by a network of civil society organisations such as Free Software, Wikimedia, Creative Commons, Communia) have been fighting for regulation and social institutions that balance private and public interests, and preserve and enlarge the digital commons. In the 2010s, digital rights activists (Postigo, 2012) achieved some important successes including the defeat of trade agreements, namely ACTA (Anti-Counterfeiting Trade Agreement), through actions such as the blackout of the most famous digital commons, Wikipedia, as a means of protest (Powell, 2016). This blackout strategy to hide portions of Wikipedia, similar to a strike, was later used again in support of freedom of panorama, a right of the public threatened by exclusive rights, in some countries, on the publication of photographs of buildings which are in the (physical) public domain (Dulong de Rosnay & Langlais, 2017).

Moving forward in a world faced with climate emergency, extreme right-wing politics, systemic inequalities, and a pandemic, we are convinced that the digital commons needs to intersect with larger power imbalances and social movements, such as the green new deal, crossing environmental and technology battles, to develop more sustainable alternatives to capitalism.

Emerging issues

Beyond creative and functional works of authorship, the model of the digital commons is expanding to more fields, with projects trying to apply the holistic framework to new domains. The governance of cities and of personal data exemplifies more recent instances of digital commons.

Urban democratic participation and commons

The commons is increasingly investigated as a political institution and as a way to expand democratic participation beyond the framework of representative democracy. This builds one of the central aspects of commons, self-governance, where the commoners come together through various online and offline fora in order to define rules of collaboration and ways to resolve conflicts based on these rules (De Angelis, 2017). Stalder (2018) sees the renewal of democracy through the commons as a way of countering the crises of the institutions of liberal democracy and their tendency to be absorbed into post-democratic frameworks. In 2017, the city of Barcelona started to implement a new commons-oriented participatory platform, decidim (Stark, 2017) while progressive governments from Iceland (Landemore, 2014) to Taiwan (Horton, 2018) used crowd-sourcing efforts to drive policy development. As an alternative to smart cities based on central governance and surveillance capitalism, commoners, hackers, cryptographers and sociologists provide commoning tools for citizens to participate online (D-Cent and Decode EU-funded projects) based on self-governance, decentralised, bottom-up values and data commons (the last type of digital commons we analyse below).

Beyond politics in a more narrow sense, the commons is seen as an enabling condition for increasing participation, flexibility and collaboration throughout society, in areas from education (“open educational resources”), to various kinds of civic engagement (“civic media”) (Gordon & Mihailidis, 2016).

Data commons and personal data

Control over data has emerged as an increasingly central techno-political issue. The notion of the data commons has been proposed against the increasing cen-

tralisation and commodification of data in the hands of a small number of companies (Mozorov, 2015). This recognises that value generated by pooling data, data mining, internet of things and algorithmic decision-making or artificial intelligence and argues that the underlying data can be governed as a commons rather than be handed over to the state and/or to surveillance capitalism. The concept of data commons tries to counter the tendency for centralisation of economic and political power that comes with the currently dominant model of amassing these pools of data as privately held assets (Goldstein et al., 2018). The notion is, however, still underdeveloped, and lacks a conceptual and legal framework as data commons is sometimes viewed as simply a collection of "open data" resources. However, it is necessary to differentiate more clearly between open data (available to all) and data commons, where the modes of access to the data can be segmented between members of the commons and outsiders. The constitution of data commons also needs to overcome the apparent contradiction between personal data and property, and between privacy and open access, as a personal data commons would not lead to sharing personal information, but to govern their reuse according to values of the digital commons. The Data Commons Manifesto (2019) is an attempt to formulate such a view.

The notion of the data commons, in its most ambitious political form, is part of a larger quest for what has been called "technological sovereignty". The sovereign here is not the isolated individual, but the city as a collective, that is the community of citizens who should be able to exercise "full control and autonomy of their Information and Communications Technologies (ICTs), including service infrastructures, websites, applications and data, in compliance with and with the support of laws that protect the interests of municipalities and their citizens" (Bria & Bain, 2019). Data commons and commons-based practices applied to personal data can be enforced by democratic platforms mentioned in the previous section, but also by cooperative platforms and open science citizen projects.

Outlook: from the digital to social commons

As the social and ecological crises escalate, we see the digital commons as no longer just a concept that is essential to the debates over copyright reform to fit the 21st century digital society, free software or open data. It rather challenges the very character of contemporary societies. Its inclusive model of sharing and participation outlines a comprehensive alternative to surveillance capitalism (Doctorow, 2020; Zuboff, 2018) and digital colonisation of social life (Couldry & Mejias, 2019).

This also means that the (digital) commons cannot succeed on their own, but are

part of a comprehensive vision of a participatory, democratic and ecological society. This requires the transformation of business models, infrastructure, governance mechanisms and social attitudes, for example as part of a "green new deal" (Rifkin, 2019). These are all necessary to rebalance the relation between individual and collective rights, whereas both singular and collective need to be understood, as Donna Haraway (2016) calls it, "entities-in-assemblages". The digital commons offers a set of ideas, practices and experiences that can inform other areas that might not be thought of as digital, but are increasingly based on digital infrastructures that allow new commons-based institutions to function effectively.

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