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MÁS ALLÁ DEL *BIG DATA*: IA GENERATIVA Y LLMS COMO NUEVAS TECNOLOGÍAS DIGITALES PARA EL ANÁLISIS DE LA REALIDAD SOCIAL

Social Sciences and Digital Technologies: A Long and Complex Path of Approaches and Interrelationships

Ciencias sociales y tecnologías digitales: un largo y complejo camino de enfoques e interrelaciones

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ABSTRACT

Since the 1970s, the introduction and gradual widespread adoption of digital technologies (DTs) have significantly affected political, economic, social and cultural aspects of society. The social sciences and humanities have been profoundly shaped by these technologies, generating new challenges regarding how these disciplines structure research and conduct scholarly activities. This article examines the current state of research in the social sciences and humanities concerning digital technologies, analysing the different approaches that have emerged, their characteristics, differences and similarities. Drawing on an extensive literature review, we propose a categorisation that classifies the range of approaches to digital technologies. These span from primarily theoretical and conceptual frameworks, to analyses of the impact of digital technologies and instrumental approaches incorporating software packages for methodological techniques, to the most recent computational approaches that have made advanced computational methods their defining characteristic: computational social science and digital humanities.

KEYWORDS: digital technologies; information and communication technologies; social sciences; computational methodologies; computational social sciences; digital humanities.

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RESUMEN

Desde la década de 1970, la introducción y paulatina masificación de las tecnologías digitales (TD) ha generado fuertes impactos en las distintas esferas políticas, económicas, sociales y culturales de la existencia. Las ciencias sociales y las humanidades no han sido ajenas a los efectos de la incorporación de estas tecnologías, empezándose a abrir nuevos desafíos en los modos, formas, técnicas y conceptualizaciones en los que estas disciplinas se estructuran y realizan sus labores de investigación. El presente artículo tiene como objetivo delinear un estado de situación respecto de las distintas corrientes que se han planteado en las ciencias sociales y las humanidades para vincularse con las TD, analizando condiciones de surgimiento, características, diferencias y similitudes. A partir de una exhaustiva revisión bibliográfica, se propone una categorización que permita clasificar el abanico de enfoques en relación a las TD. Se consideran aproximaciones centralmente teórico-conceptuales, análisis de impactos de las TD, movimientos instrumentales de incorporación de paquetes de software informáticos para técnicas metodológicas, hasta aquellos enfoques computacionales reflexivos más recientes que han hecho de la incorporación de técnicas informáticas avanzadas su característica fundacional: las ciencias sociales computacionales y las humanidades digitales.

PALABRAS CLAVE: tecnologías digitales; tecnologías de la información y la comunicación; ciencias sociales; metodologías computacionales; ciencias sociales computacionales; humanidades digitales.

1. Introduction

Within the context of various forms of competition involving the United States and the USSR during the Cold War, research incentives were promoted around numerous technological developments, particularly regarding digital technologies (DTs) (Gendler, 2023; Galliano, 2024). These developments converged with other factors: the exhaustion of the industrialist model that culminated in the 1973 oil crisis and the microelectronics revolution at the beginning of the 1970s (Castells, 1999); various government plans to computerise society, such as the one prepared in 1971 by the Japan Computer Usage Development Institute (JACUDI) and the Nora-Minc report, published in France in 1978, among others (Mattelart, 2002); the abandonment of the gold standard in favour of the dollar in 1971, together with the 1985 Plaza Accord, after which risk capital flows were redirected primarily towards the telecommunications sector (Srnicek, 2018); and the gradual but firm advance of neoliberalism as a framework of intelligibility (Foucault, 2007). These elements, among others, enable us to understand the shift from an industrial development model based on matter and energy towards a new type of society: an information society, where information and knowledge – concretised in information and communication technologies (ICTs) generally, and DTs particularly – constitute the main input of this new mode of informational development (Castells, 1999). Within this framework, the development and penetration of computer and digital technologies since the 1970s have generated substantial effects across all spheres of social, political, economic and cultural life.

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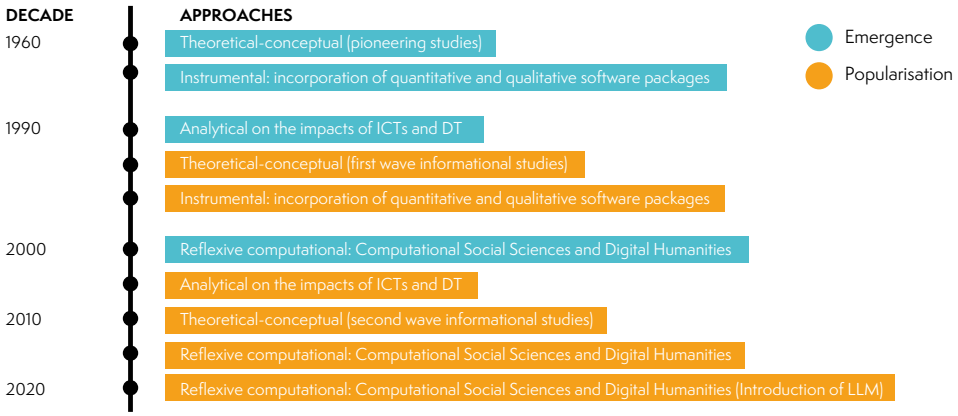
The social sciences and humanities have been profoundly affected by the incorporation of these technologies, opening new challenges in the methods, forms, techniques and conceptualisations through which these disciplines structure and conduct research.

This article outlines the ways in which the social sciences and humanities have engaged with DTs from their emergence in the early 1970s to the present. Drawing on an extensive literature review supplemented by key informant testimonies,[1] we develop a categorisation to classify the range of approaches and currents linking the social sciences and humanities to DTs, considering socio-historical conditions of emergence, characteristics, principal exponents, focal points, differences and similarities. These relationships are examined from a socio-historical perspective, differentiating between positions focused on theoretical–conceptual issues and those centred on software package usage, while acknowledging mixed positions. Accordingly, four main approaches can be proposed: a primarily theoretical–conceptual approach; studies and analyses focused on the impacts of DT; instrumental approaches that incorporate computer software packages for methodological purposes; and reflective computational approaches, such as (computational social sciences and digital humanities).

Diagram 1

Approaches linking the social sciences and humanities with ICTs and DTs, by decade of emergence and popularisation



Source: own research.

Any categorisation necessarily involves overlaps between categories. A further clarification is needed: although this article is structured to address macro-global trends and currents, many observations and the consulted literature may reflect the author's socio-territorial and contextual positioning. In other words, while this work aims to portray and categorise the links between the social sciences, the humanities, and DTs in the Western Hemisphere, it may place greater emphasis on Spanish-language literature produced in, or particularly influential within, Latin America and the Southern Cone.

2. Theoretical–Conceptual Approaches

The first approach addressing the link between these disciplines and DTs is also the first to emerge chronologically. It encompasses theoretical–conceptual elaborations generated from the social sciences and humanities whose primary focus is societal transformations, with particular emphasis on the role of telecommunications, ICTs generally and DTs specifically. Notably, even before the events highlighted in the introduction – which we postulate as the main vectors of change towards an information society and the drivers of DT development and penetration – a varied range of analyses warning of transformations in industrial societies had already emerged since the late 1950s.

Following Sánchez Torres, González Zabala and Muñoz (2012), with some additions, it is possible to identify in these early elaborations writings on post-capitalist society (Dahrendorf, 1959), the information society (Masuda, 1962), the knowledge economy (Machlup, 1962), the knowledge society (Drucker, 1969), the technotronic era (Brzezinski, 1970), post-industrial society (Touraine, 1971 and Bell, 1973), the information economy (Porat, 1977), the computer revolution (Tomeski, 1970 and Hawkes, 1971), the computerised society (Martin and Norman, 1970), the post-liberal age (Vickers, 1970) and risk societies (Beck, 1986), among others.

These early analyses – particularly Bell (1976) – focused on identifying a new pre-eminence of theoretical and applied knowledge in the productive sphere, analysing the changes generated and highlighting the role of sectors that produced, interpreted and disseminated such knowledge. The new form of society superseding the industrial one was characterised by the shift from a commodity-producing to a service-producing economy; the pre-eminence of professional and technical classes; the centrality of theoretical knowledge as a source of innovation and political formulation; regulatory controls to reduce uncertainty in technological innovations; and the creation of new "intellectual technologies" influencing decision-making by reducing risks caused by the "human factor". Importantly, in these pioneering analyses, technologies occupied a secondary role, being merely part of the concretisation of knowledge innovations. This was also due to the limited circulation and availability of

ICTs and DTs across different spheres, which were not yet considered central factors in societal changes.

This began to change during the 1990s. The fall of the USSR in 1991 and consolidation of the neoliberal paradigm centred in the United States; the promulgation of more concrete computerisation plans such as the European Community's Bangemann report in 1993, the USA's Information Highways in 1994 and a revised version of Japan's JACUDI plan; the invention of the world wide web in 1991 and the browser in 1993; the opening of the internet to both the business world and a broader user base in 1994; the gradual reduction in costs of personal devices and network connection plans; and the crisis in cultural industries alongside strengthened intellectual property regulations – these are just some of the principal historical–contextual factors that explain the growing presence and impact DTs began to have across different social spheres (Gendler, 2023). Within this framework, a second wave of theoretical–conceptual elaborations emerged, including writings on the society of control (Deleuze, 1990), postmodernity and time–space compression (Harvey, 1990), post-Fordism (Lipietz and the Regulation School, 1994), high modernity (Giddens, 1994), the information age (Castells, 1995 and 1999), the knowledge-based economy (OECD, 1996), turbo-capitalism (Luttwalk, 2001), cognitive capitalism (Boutang, Rullani and Vercellone, early 2000s) and immaterial capitalism or empire (Hardt and Negri, 2004), among many others.

Unlike the pioneering works, these productions – while continuing to argue for the pre-eminence of knowledge as a key factor differentiating the changes from those of industrial society – identified a central role for ICTs and DTs both in the creation, dissemination and modification of information/knowledge and as the principal driving mechanisms of changes in capitalist configuration. In other words, the new informational configuration was characterised as primarily oriented towards knowledge accumulation, acceleration and flexibility of roles and processes, and improved information processing capacity via technological development (Castells, 1999). Likewise, several works addressed new challenges introduced by the dismantling of the welfare state and the hegemony of neoliberal policies closely linked with the expansion of ICTs and DTs.

After the 2000s, following the dotcom bubble crisis in 2001, events such as the emergence and rising popularity of social networks between 2002 and 2008; the international economic crisis of 2008; the creation of the smartphone in 2007; the consolidation of the digital platform model during the 2010s (and its attendant scandals); the COVID-19 pandemic; the dramatic expansion of social datafication; and the explosion of generative artificial intelligence in the early 2020s enable us to identify a second stage within the informational paradigm (Gendler and Girolimo, 2025; Galliano, 2024) – one more focused on data and their processing – and a third wave of theoretical–conceptual elaborations. Within this framework, we can identify productions on the hypermediated

society (Scolari, 2008), the performance and burnout society (Han, 2012), the second machine age (Brynjolfsson and McAfee, 2014), cybernetic capitalism (Tiqqun, 2015), the industry 4.0 society (Schwab, 2016), platform capitalism (Snircek, 2016), platform society (Van Dijck, Poell and De Waal, 2018; Zukerfeld, 2020), the silicolonisation of the world (Sadin, 2018), surveillance capitalism (Zuboff, 2019), capitalism 4.0 (Galliano, 2020), infocracy (Han, 2021) and technofeudalism (Durand, 2021; Varoufakis, 2023), among many others.

While these works present significant differences in terms of expectations, concerns and modes of analysis, they all identify a new set of DTs much more focused on the storage, processing and application of vast datasets for the social modulation of individuals, collectives, institutions and processes of all kinds. Likewise, several of them analyse the intertwining of DTs and social processes, indicating their degree of intensification and contemplating new actors of great importance in the form of major technology companies ("Big Tech"), proposing various interpretive frameworks for their understanding.

It should be noted that, despite coexisting temporally with the development of multiple software packages for social research,[2] the output within this approach has not made extensive use of them, prioritising theoretical–conceptual work[3] and, at least at an operational level, constituting the "least digital" of the perspectives proposed here.

3. Analytical Approaches to ICT and DT Impacts

The second approach encompasses research focusing mainly on the impacts and effects of ICT and DT introduction and penetration across different social dimensions: education, work, sociability, tourism, urban planning, social assistance, social protest and many others.

As previously mentioned, published works within the theoretical–conceptual approach have focused on developing broad explanatory and interpretive frameworks regarding the reasons and causes of societal transformations, examining the leading role of information, knowledge and different ICTs and DTs. While many have explored the effects of these modifications on different aspects of social existence, this was often done contextually or illustratively, without substantial depth or systematic analysis. This task has been taken up by another stream of academic work on ICTs and DTs – one more specialised and centred on their impacts and transformations within specific dimensions. Within this perspective, it is also possible to identify the gradual incorporation of software packages for social research, encompassing both quantitative and qualitative techniques.[4] The main indications of this begin in the 2000s, in many cases supplementing or replacing manual and analogue techniques and processes with these computer programs.

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Research and works within this approach shares the following characteristics. First, it focuses on the analysis of socio-technical impacts, prioritising a single dimension. Examples include the effects of the introduction of technology in university teaching, reconfigurations of informational work, digitisation of files and processes in state institutions, new technology-mediated processes and urban management, new artistic expressions within digital culture, message circulation on social media platforms, online social movements and collective action, new consumption patterns and forms of expression on social networks, among many others.

The vast majority of studies on the impacts of DTs draw upon one or more theoretical–conceptual frameworks, focusing on researching, describing and/or analysing the effects arising or observed in the selected dimension and field. This perspective emphasises empirical work over theoretical–conceptual construction, for the most part applying, deepening, testing, refuting and/or adding complexity to these general frameworks regarding the specific topics addressed. Notably, in some cases, new theoretical–conceptual tools are produced, though these present a lower level of abstraction compared to those generated in the broader frameworks of the previous approach, often requiring conceptual bridges between macro-level theoretical–conceptual perspectives and observed phenomena. Examples include digital inclusion practices (Crovi Druetta, 2004), "digital natives" (Piscitelli, 2008), collective action on social media (Lago Martínez, Gala and Samaniego, 2023; Sierra Caballero, 2020), the social appropriation of technologies (Morales, 2009) and platform work (Negri, 2020), among many others. These works begin to emerge in the mid-1990s, becoming especially prominent from the 2000s onwards, reflecting the expansion of DTs and the internet and, consequently, the greater presence and impacts across different dimensions of social existence. As with the previous current, these analyses are shaped by the socio-technical context of their period, in several cases concentrating research efforts on the impacts of the most recent and disruptive DT configurations.[5]

4. Instrumental Approaches: Incorporation of Methodological Software in an Instrumental Way

We arrive here at a complex point. As mentioned, this article aims to address and categorise the different ways in which the social sciences and humanities have engaged with DTs. It is therefore necessary to consider another stream—one that has achieved the widest uptake while remaining perhaps the least specific on this issue. In other words, this stream frames the relationship between the social sciences and the humanities in relation to DTs as largely instrumental and applied: an "approach that is not an approach" in itself, yet one that cannot be overlooked. We refer to a heterogeneous movement consisting of the gradual incorporation of computational methods into research practice through the digitisation of methodological techniques.[6] However, this perspective did not necessarily imply or require self-reflection or the elaboration and/or incorporation of theoretical–conceptual frameworks (such as those present in the first approach) for this purpose. Rather, specialised software packages for research application were viewed more as "tools",[7] and their widespread acceptance as the replacement of "manual tools with computational tools".[8] This third approach thus corresponds to all those investigations and academic works that have used computer programs to carry out quantitative or qualitative techniques without requiring reflection on their use, design and implications, without drawing upon theoretical–conceptual frameworks that contribute to a greater understanding of their use and, in many cases, without the research necessarily being focused on or related to DTs and their effects across different dimensions of society.

As with the theoretical–conceptual and analytical approaches addressing the impacts of DTs, the introduction and widespread adoption of these software packages and their potentialities is shaped by the technological advancement of their time. Created in the 1960s and 1970s, the first computer programs applicable in social research were almost entirely those that could perform quantitative tasks, principally digitisation of databases and survey results, cross-tabulations, regressions and statistical relationships, and digital graphics, among others, with OSIRIS, BMDP (Bio-Medical Data Package), SPSS (Statistical Package for the Social Sciences) and SAS (Statistical Analysis System) being particularly prominent. In the mid-1980s, they were joined by another computer program that remains important to this day: STATA. Conversely, the first software packages for qualitative techniques date mainly from the 1980s and 1990s, notably Ethnograph, Hiperqual, MAXQDA, T-Lab and NUD*IST (Non-numerical Unstructured Data Indexing Searching and Theorizing) – predecessor of today's NVivo – and ATLAS.ti, the latter equipped with tools focused on the principles of grounded theory.[9]

It is important to note that, beyond the existence of these computer programs, multiple factors shaped the ways in which they were introduced and incorporated into the social sciences and humanities. Given the scarcity of written sources, this historical account relies on testimonies from five key informants from different

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regions who experienced first-hand the incorporation of computer programs into their academic work and university curricula.

Firstly, availability and infrastructure were important factors to consider. When these software packages emerged, the vast majority of social sciences and humanities researchers either lacked the necessary equipment to use them or did not possess the knowledge and skills to do so.[10] In this regard, the absence of graphical interface operating systems – such as those popularised in the mid-1990s – was a major obstacle to the widespread application of these computer programs. Their use was intended for those with practical knowledge in the use of punched cards and, subsequently, programming and/or syntax development. For these reasons, in most cases an association had to be formed between researchers in the social sciences and humanities and systems engineering personnel – the latter would generate tables, variable cross-tabulations and statistical trends, while relying on the former for analysis and interpretation. While many of these collaborations were fruitful, there were also frequent communication and interpretation problems between the two sectors (Colombrans, 1999).

Likewise, the process of incorporating these software packages differed across regions. According to the testimonies collected, these computer programs were introduced into social sciences and humanities university curricula in Europe and the United States by the mid-1980s (especially in sociology), gradually spreading to academic and private practice. In Latin America, by contrast, this occurred in the mid- to late 1990s, and the strategic alliance with the IT sector has continued to the present day. Differences in computer equipment availability and processing capacity between regions also help explain these variations.

Secondly, it is important to understand that, beyond being interpreted as "tools", the design features of these software packages played an important role in how they were incorporated and used. In the 1980s, the software enclosure movement (Gendler, 2023)[11] also affected these computational developments, preventing users from accessing the code, modifying or adapting it for specific needs, and generating new versions. This restricted use not only to the technical characteristics imposed by companies but also made it dependent on purchasing licences.

These issues are significant. Over two decades, social and human scientists had to gradually acquire substantial technosocial knowledge about using these computer programs in their academic and professional practice, and this became almost essential by the beginning of the 2000s. While their use expanded information processing capabilities, accelerated timelines and improved collaborative work possibilities, their closed-source and proprietary nature also guided and limited many research possibilities and practices.

5. Reflective Computational Approaches: Computational Social Sciences and Digital Humanities

Kirschenmaum (2012), Gold (2012) and Zhang *et al.* (2020) argue that methods and software packages introduced into social sciences and humanities research from the early 1960s onwards established a distinctive new field within these disciplines. Within the humanities, discussions began opening up from the late 1980s about whether the use of DTs made it possible to conceive of a new disciplinary branch. In these exchanges, various approaches and reflections were gradually incorporated into practice with computer programs, particularly around the scope, perspectives and problems that the use of these DTs brought to their work (Chow, 2015). After two decades of discussions, conferences and exchanges, this movement adopted the name "digital humanities" (DH) by consensus (Chow, 2015; Kirschenmaum, 2012), defining itself not only as a common methodological and epistemological perspective linked to DTs, but also as a social enterprise, an attractive element for investment and funding, with a long shared trajectory (Gold, 2012).

In contrast, computational social sciences (CSS) followed a different path. Most authors agree that CSS originated in 2009, with the publication of the eponymous article in the journal *Science*. In it, the authors – recognising the new leap in scale of datafication after the great expansion of the internet in the mid-1990s, the emergence of web 2.0 in the early 2000s (Gendler, 2024; Gualda, Taboada Villamarín and Rebollo Díaz, 2023) and other means of obtaining information such as sensors, public statistics and GPS (Gualda, 2022) – argued that the availability of massive data volumes provided the social sciences with new opportunities to enhance their disciplines, as had happened with biology, physics (Lazer *et al.*, 2009) and business intelligence (Gualda, 2022). They highlighted the potential of working with "data that represent/indicate the reality of what people do", complementing data obtained through more traditional techniques such as surveys and interviews, which mostly are "data that reflect what people declare, not necessarily what they do" (Giles, 2012). They further argued that technology companies such as Google and Facebook were already conducting CSS work, necessitating engagement from academia and universities. However, authors such as Zhang *et al.* (2020) dispute this "origin milestone", arguing that CSS can already be observed in the early incorporation of software packages into social science research practices in the early 1960s. For these authors, the paper by Lazer *et al.* (2009) defined and popularised CSS but did not found it. Instead, it continued pre-existing movements around data-based CSS, with the processing of large volumes of data at its core.

Beyond these controversies, this section proposes a *different* approach to the instrumentalist one. In our perspective, the central characteristic of CSS and DH is not merely introducing and massively using new computational techniques – mainly for collecting, treating, processing, analysing and

validating large volumes of data – but also producing and deploying new concepts, theories, reflections, approaches, discussions and even a new epistemological paradigm about the scope, opportunities, limitations and challenges of their introduction (Conte *et al.*, 2012; Chow, 2015). As Conte *et al.* state in their "Manifesto of Computational Social Science":

> […] it is clear that naive or brute-force incorporation of large-scale data into simulation models may not lead to the expected results in terms of achieving relevant progress in social science. […] In conclusion, computational social science, as a rapidly developing and successful field, needs to be aware of the necessity to develop its theoretical premises, and to test them. Much as physical theories and models are tested through incredibly large experiments (such as the LHC at CERN), progress in computational models of social phenomena will only be possible by a sensible combination of data input, experimental work, and theory devising (2012, pp. 342–343).

This issue is key. It enables – beyond the differences in the computer programs used – a clearer distinction between the instrumentalist approach and the reflective computational approach. The latter, comprising CSS and DH, shares a dual focus in its engagement with digital technologies: on the one hand, the introduction of new computational techniques; and on the other, a self-reflective practice and theoretical–conceptual production surrounding these techniques and their disciplinary implications. In other words, CSS and DH not only incorporate computational software typical of the second wave of informational capitalism (Gendler and Girolimo, 2025) – strongly linked to social data, large data volumes (big data), small volumes of specialised data (small data) and new artificial intelligence models – but also produce, reflect upon and elaborate theoretical–conceptual frameworks. These frameworks operate at a lower level of abstraction than those in the first approach discussed in this article, yet they give meaning, direction and recursive capacity to their research lines and tasks.

However, this general definition requires examining the specificities of this new type of link with DTs. The software and DTs used by CSS and DH have different characteristics compared to those used by the instrumental approach.

Firstly, during the 1990s most software applied in social research was proprietary and closed-source. Specialised open-source or free software packages existed, but their presence was limited. However, this changed in the early 2000s. The free software and culture movements gained momentum at the beginning of this decade, operating with a collaborative logic aimed at co-creation (Gendler, 2023). This was reflected in greater promotion of specialised programs with these characteristics. The R programming language emerged in the mid-1990s as a free and open-source tool, but gained widespread use in universities and research centres only in the 2000s,

especially in the social sciences. This growth partly stems from the emergence of R Commander, a specialised graphical environment for statistical use developed by the Department of Sociology at McMaster University (Fox, 2005). The popularisation of R and its various toolkits was also nurtured by researchers around the world who collaboratively created different packages with distinct functionalities, including highly efficient tools for collecting, processing and analysing large volumes of data. This process peaked in the early 2010s with the emergence and popularisation of the RStudio integrated development environment, which facilitated and encouraged collaborative creation and use (Llaudet and Imai, 2024). In parallel, the free Python programming language, created in the early 1990s, also gradually gained popularity, spreading first among engineers, economists and data scientists. In the 2010s, with the creation of packages such as *Pandas*, *Jupyter* and the different notebooks, it became widely used in the social sciences and humanities (Trillin, 2018). Gephi, another open-source software package that was first released in 2008, is used mainly for network visualisation and analysis.

Secondly, CSS and DH gradually incorporated various developments in the field of artificial intelligence – mostly machine learning, but also deep learning and natural language processing (NLP) – that were launched and popularised in the early 2000s. Gualda, Taboada Villamarín and Rebollo Díaz (2023) and Zhang *et al.* (2020) note that incorporating these tools was fundamental to expanding the explanatory and predictive capabilities of these computational disciplines, especially when working with large volumes of data. Supervised learning techniques (such as decision trees, Bayes classifiers, random forests and support vector machines [SVMs]) and their unsupervised counterparts (such as linear discriminant analysis [LDA], expectation-maximisation algorithms, k-means clustering and word embedding models) significantly broadened these disciplines' fields of work. Researchers also constructed data-driven simulation models (Conte *et al.*, 2012). More recently, large language models (LLMs) and prompt engineering have deepened work with AI in the 2020s. Application topics include studying human characteristics, behaviours and actions; predicting and modelling these behaviours; and identifying influencing factors and consumption patterns. They also include analysing digitised written media for key terms and topics; establishing and developing networks; analysing discourse, political image and public opinion; examining mutations in community structure and behaviours; measuring levels and directions of social interaction; and studying emerging social processes and multilevel interactions (Zheng *et al.*, 2020).

A final clarification is needed regarding this approach. Despite the similarities emphasised in this section, CSS and DH differ in important ways. They have different backgrounds and comprise different disciplines with distinct approaches. They also introduced AI-based computational methods differently. CSS (especially sociology) more commonly focuses on predicting,

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analysing and classifying large volumes of data (big data), while DH works more with smaller, specialised data volumes (small data) and emphasises techniques such as digital ethnography, digitised analysis of literary corpora, geographic information systems, gamification and interactive narratives (Gualda, Taboada Villamarín and Rebollo Díaz, 2023; Chow, 2015). However, CSS and DH increasingly overlap and exchange ideas, and are often treated together due to their strong similarities (Romero Frías and Sánchez González, 2014; Caro *et al.*, 2020; Gefen, Saint-Raymond and Venturini, 2020). Despite acknowledging their singularities and differences, this article views both as part of the reflective computational approach because they share two key characteristics: they use advanced computational methods from the second wave of information, strongly linked to data analysis, and they produce theoretical–conceptual elaborations and reflections on the potentialities, implications and problems of these methods.

6. Categorisation of Approaches to Links: A Synthesis

Table 1 summarises what has been discussed so far.

Table 1

Categorisation of approaches linking the social sciences and humanities with ICTs and DTs

	Linking social sciences and humanities with DTs	Focus	Short definition	Approximate emergence
1	Theoretical–conceptual approaches	Changes in macrosocial configurations in connection with the widespread adoption of ICTs and DTs.	Theoretical–conceptual elaborations that address and problematise structural changes in the capitalist system linked to ICTs and DTs, their motivations, their socio-technical, economic, political and cultural effects, and associated continuities and discontinuities.	1950–1990 (pioneering research), 1990–2008 (first wave of information research), 2008–present (second wave of information research).
2	Analytical approaches on the impacts of ICTs and DTs	Impacts and effects of the introduction and penetration of ICTs and DTs across the different social dimensions.	Addresses the effects and problems arising from the introduction and expansion of ICTs and DTs, focusing mostly on a specific dimension (education, work, sociability, health, tourism, social assistance, management of production processes, social protest, etc.). Draws on theoretical–conceptual elaborations. Can generate its own concepts but with a lower level of abstraction.	Mid-1990s, became popular from the early 2000s due to increased presence of DTs and the internet across social dimensions.
3	Instrumental approaches	Introduction of computer programs to carry out research tasks.	This "non-approach approach" focuses on incorporating computer programs for social research tasks, classifying them as "tools". Does not necessarily elaborate or draw upon theoretical–conceptual frameworks linked to DTs, nor is investigating their effects essential. Instrumental approach, widely disseminated. Mostly uses closed-source/proprietary software.	Incorporation of these software packages dates mainly from the 1960s and 1970s, achieving widespread adoption and popularisation between the 1980s and 1990s.
4	Reflective computational approaches: computational social sciences and digital humanities	Introduction of new-generation computer programs, together with theoretical–conceptual elaborations and reflections on their implications, effects and scope.	This approach incorporates software packages typical of the second wave of informationalism, mostly open-source or free software, working with data volumes (big data and small data) and AI tools (ML, DL, NLP) to increase the potential for prediction, explanation and simulation of social phenomena. Includes theoretical–conceptual elaborations (of a lower level of abstraction and complexity than those of the first approach), reflections and debates on the effects, scope and implications of using these specific software packages.	Early 2000s thanks to availability of collaborative free software, new volumes of available data and developments in AI. Increased popularity from the 2010s. In-depth studies from the 2020s incorporating LLMs and prompt engineering.

Source: own research.

The proposed categorisation of approaches concerning social sciences' engagement with DTs is not intended to close debates but rather to provide a framework that might help advance and structure them. This proposal acknowledges that several points of contact may exist between the different approaches. The approaches that analyse the impacts of ICTs and DTs connect with theoretical–conceptual approaches when researchers draw upon theoretical frameworks to study technology effects in particular dimensions. Conversely, theoretical–conceptual elaborations are often informed by research into the impacts of DTs, which prompts new theoretical adaptations and reworkings. Instrumental and computational approaches can also be combined with and connect to those focused on theoretical–conceptual elaborations and those that analyse the impacts of DTs. For example, research might draw on theoretical–conceptual frameworks about the current informational age (first approach), analyse the effects of DTs in a specific social dimension (second approach) and apply first-wave computational techniques (such as SPSS, STATA, Atlas.ti and NVivo) without reflecting on their use, implications or scope (third approach). Alternatively, the same type of research might instead apply second-wave computational techniques (such as RStudio using the tidyverse package or Python using Pandas) and include reflections or theoretical frameworks on their use, implications and scope (fourth approach).

7. Open Thoughts

This article has traced how the social sciences and humanities have interacted with ICTs and DTs, proposing a typology of these relationships. This allows us to reflect on several fundamental issues.

Firstly, instrumental and reflective computational approaches appear almost incompatible as they use different types of programs and differ fundamentally on whether critical reflection is necessary. However, even early instrumental research often included some paragraphs or sections justifying the use of computer programs that complement or replace manual quantitative or qualitative techniques, citing specialised literature as validation. But this justification was purely operational, fitting within the instrumental perspective that this stream maintains towards computer programs – it did not reflect on their characteristics, scope, opportunities or problems. Over time, the habitual use of specific software packages in CSS and DH could also fall into this instrumental perspective. Researchers might stop justifying their use and, more importantly, stop incorporating the necessary critical reflections. This is a risk that deserves our attention.

Secondly, readers may have noticed potential subcategories within the proposed approaches. The theoretical–conceptual approach can be divided according to socio-historical stage: pioneering studies, first informational wave and second informational wave. The analytical approach on the impacts of ICTs and DTs

might include subcategories based on combinations of dimensions addressed, or on approaches to the effects of technology penetration using other theoretical–conceptual frameworks not specialised in these technologies.[12] Another division could include work that focuses on the effects of DTs but examines multiple dimensions rather than restricting analysis to a single area, attempting a more comprehensive approach. Additional subcategories might examine actors, roles, contexts and impacts at lower abstraction levels than the theoretical–conceptual approach. Examples include Science, Technology and Society (STS) studies, Discourse Analysis and the Political Economy of Communication, among many others.[13] The instrumental approach might be divided by separating quantitative from qualitative software, proprietary from free software, or by analyses that include reflections on non-instrumental use of computer programs. The reflective computational approach could be divided between CSS and DH, by studies with more instrumentalist tendencies, or by objective (prediction, explanation, simulation), among other possibilities. In this sense, this article aims to establish foundations for a theoretical–conceptual and methodological tool that contributes to studying the broad field of links between social sciences, humanities and DTs. All these possibilities for expansion (and others not mentioned) are welcome.

Thirdly, the socio-technical context – both technological availability (general software packages, specific programs, equipment, infrastructure, etc.) and reflection and analysis of the presence and impacts of ICTs and DTs – is crucial, as it is inseparable from all the approaches deployed. Greater existence, circulation and popularisation of technologies increase both their effects on society and interest in studying them. Greater capacity and socio-technical disruption also open new forms of approach and analysis. In any case, the technologies themselves should also be studied: their characteristics, the actors who create and drive them, and whether their code is proprietary/closed or free/open. These are central elements requiring contemplation and analysis, yet they are often ignored.

This raises another important point. Since the 1970s, many academic works have "run after the latest novelty" without considering the history of the technologies addressed, the actors involved and their power relations, geopolitical issues, or the operation and design characteristics of the ICTs or DTs in question – all fundamental for comprehensive study. Similarly, socio-technical innovation has often dominated research themes, methods and approaches, both in trends and funding. This has sometimes led to research using "advanced" computer programs when the research does not require them or, worse, limiting research impacts and objectives to enable use of these technological developments. This is why self-reflection and specific, constant work on computational methods are defining features of CSS and DH – and why they must be preserved. Without them, these approaches risk relapsing into instrumentalism that undermines their potential.

Finally, the geographic location of research is a key factor. Across all approaches, research conducted in the Global North–particularly in the United States and

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Europe–has consistently shaped research agendas in the Global South (Latin America and elsewhere). As a result, the Global South has relied heavily on the Global North for theoretical–conceptual and epistemological frameworks, computer programs and their possible applications. This occurs for two reasons. First, ICTs and DTs are more available and circulate more widely in the Global North. Second, launches and developments are rolled out there first, creating the socio-technical framework that promotes research and usability before reaching the Global South later. Nevertheless, once technologies reach the Global South, rich academic production emerges with different contexts, cases, particularities and interpretations. However, this Global South production often remains invisible to the Global North. This issue is not unique to ICT and DT studies – it is historical. But perhaps these fields offer an opportunity to develop more bilateral relationships.

This article has examined the state of affairs and proposed a theoretical–conceptual and methodological framework for understanding links between the social sciences, humanities and DTs. Future research – our own and, hopefully, others' – must continue to expand, modify, rework, specify and optimise what is presented here to contribute to this necessary and urgent framework of approaches.

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Notes

1 This methodological strategy was necessary due to difficulties accessing written records of the inclusion of computer software in the social sciences and humanities between the 1960s and 1990s. Five experts from different regions were consulted, all with extensive experience, to complement and deepen information about these periods and processes. They were selected for having experienced these processes directly, with careful consideration given to achieving gender and geographic balance. Their testimonies provide informative context to this article.

2 These will later be described as the instrumental and reflective computational approaches of the present work.

3 In the first decades, this may have stemmed from a disconnect between the social sciences and humanities regarding these computer programs. However, even after their popularisation from the mid-1990s onwards, their use by works in this approach remains largely limited.

4 Mainly those that compose the instrumental approach of this article, presented in the next section.

5 Work on the impacts of social media, digital platforms and generative artificial intelligence across different dimensions provides a good example.

6 This shift occurred alongside the introduction of other less specialised but equally important computer software: word processors, spreadsheets and digitised slides, among others. These became massively popular over the decades, becoming quasi-essential requirements between the late 1990s and early 2000s.

7 This instrumental view of technology (Parente, 2010) has its own origins and involves various complexities. Taking technical development as a "neutral" instrument that can be given "good or bad use" can obscure many of its differential characteristics, design biases and even its political nature. This is important because even the most reflective sciences – the social sciences and humanities – accepted and were influenced by this utilitarian approach.

8 Although initially some explanatory framework was needed regarding the software used and its advantages and limitations compared to manual practice, its use gradually became naturalised. This detail became almost irrelevant, particularly for the most popular software.

9 "Atlas.ti [is] the main computer tool for developing grounded theory. This program was designed in the late eighties by the German Thomas Murh, who resorting to technology

made an attempt to apply the methodological approaches of Glaser and Strauss" (San Martín Cantero, 2014, p. 114; own translation).

10 This is interesting to reflect upon, as it parallels what is currently happening with generative artificial intelligence models, both regarding subscription costs for premium versions and the techno-social skills around their use and appropriation.

11 We refer to the process that took place at the beginning of the 1980s, in which shared access was gradually removed from computer program code, making it increasingly difficult to understand how software worked, modify it or distribute new versions. This is when proprietary software emerged as a category. In response, the Free Software Foundation (FSF) was established in 1985 to promote free software as an alternative.

12 This case has become increasingly prominent since the COVID-19 pandemic made considering the ICT and DT dimension almost indispensable when analysing multiple fields of study.

13 Many readers might consider this potential subcategory as a distinct approach, something worth exploring in future work.