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► **To cite this version:**

Fabrizio Li Vigni. Fostering Interdisciplinarity in the Social Sciences. A Critical and Normative Comparison between the "Expansionistic" and the "Merging" Boundary Works. 2024. hal-04693020

HAL Id: hal-04693020

<https://hal.science/hal-04693020v1>

Preprint submitted on 14 Sep 2024

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Fostering Interdisciplinarity in the Social Sciences. A Critical and Normative Comparison between the “Expansionistic” and the “Merging” Boundary Works

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Abstract

In theory, interdisciplinary research should embody the connection and integration of different disciplines’ tools, approaches and communities. In the literature, the concept refers to collaboration, complementarity and synthesis. However, there are instances where interdisciplinary research, whether conducted individually or collectively, faces criticism for being asymmetrical or even imperialistic. This criticism arises when social resources, epistemic frameworks, ontological views, and normative stances are unbalanced, favoring one discipline over others. In such contexts, one perspective dominates across all these dimensions, resulting in the devaluation of alternative perspectives involved in the research. This normative paper explores and provides examples of two contrasting approaches to interdisciplinarity drawn from complexity sciences: the “expansionistic” approach and the “merging” approach. The former is examined through a critical analysis of a case study on “urban science,” while the latter offers a normative proposal based on examples from “computational social sciences.” The article draws upon interview data and bibliographic materials, and mobilizes the concept of “boundary work” coined by Thomas Gieryn to describe the strategies employed by scientists to establish and safeguard their socio-epistemic boundaries.

Keywords

Interdisciplinarity, urban science, complexity, computational social sciences, normativity, Thomas Gieryn, Science and Technology Studies

Introduction

The development of numerical methods over the past forty years, driven by the increasing computing power and the rise of data science, represents a source of both renewal and tension for the social sciences (Bastin & Tubaro, 2018; Edelmann et al., 2020; Marres, 2017). More generally, the collaboration between the social sciences and the natural and engineering sciences produces frictions and debates around interdisciplinary practices (Broca, 2016; Callard & Fitzgerald, 2015; Larregue, 2018; Lemerle & Reynaud-Paligot, 2016; Rabinow & Bennett, 2012), contributing to the extensive body of literature that explores interdisciplinarity as a study object (Chen et al., 2015; Frodeman et al., 2017; Klein, 2008; Larivière & Gingras, 2010; Louvel, 2020; Stehr & Weingart, 2000). From the theoretical literature on the matter, one would expect that interdisciplinary research implies the integration of different disciplines' tools, approaches and communities, in a context of collaboration in view of synthesis and the production of new results. However, there are several empirical examples where interdisciplinarity, whether conducted individually or collectively, faces criticism due to the dominance of one perspective over others. Such criticism arises when social resources, epistemic frameworks, ontological views, and normative stances suffer from a lack of balance. How can we, as researchers, avoid to create or to fall into these asymmetric conditions and how can we contest them when we suffer from them? How can we recognize this asymmetry in the first place?

To answer these questions, this paper explores and provides examples of two contrasting approaches to interdisciplinarity – the *expansionistic* and the *merging* “boundary work.” Coined by American sociologist of sciences Thomas Gieryn, this concept encapsulates the strategies employed by scientists to establish and safeguard their socio-epistemic boundaries (Gieryn, 1999). While Gieryn identifies three forms of boundary work (“exclusion,” “expansion,” and “protection of autonomy”), this paper introduces an additional dimension to describe successful cases where the frontiers of distinct disciplines merge together, temporarily or permanently, and produce something

new.

A secondary contribution of this paper lies in characterizing the expansionistic and merging boundary works through three sets of concepts:

Expansionistic boundary work

- “neglect and exclude”
- “transfer and reduce”
- “naturalize and depoliticize”

Merging boundary work

- “acknowledge and articulate”
- “combine and enrich”
- “denaturalize and repoliticize.”

As an ensemble, these couplets establish a conceptual and operational framework of axes for evaluating interdisciplinary efforts, whether they are one’s own or others’. Therefore, this text is better classified as a position paper rather than a research article. It constitutes a normative contribution to the theoretical literature on interdisciplinarity grounded in empirical data. In this context, fieldwork material and primary literature serve the purpose of advocating a specific position aligned with practical implications, rather than presenting previously unpublished data. It is important to note that the binary differentiation made in these pages is of course an oversimplification of the actual socio-epistemic complexity, as instances of interdisciplinary work exist along a spectrum. Yet, the intention of this paper is to offer guidance and educational insight, particularly to young researchers initiating or considering interdisciplinary efforts in or with the social sciences. This is achieved through a critical examination and an operational proposal based on real-world examples.

The first section of the article describes materials and methods, while the second problematizes

asymmetric interdisciplinarity and justifies the choice of the terms to describe the two contrasting approaches analyzed in the paper. The third section criticizes the expansionistic boundary work by examining a case study focused on “urban science,” a field that utilizes tools from physics and computer science to propose overarching theories of city evolution and dynamics. Finally, the fourth section presents a normative proposal for engaging in symmetric interdisciplinarity based on examples from “computational social sciences” within the merging boundary work. In particular, illustrations come from sociology of sciences, political science, and economics.

Materials and methods

Scholars distinguish between three ways of joining disciplines: multidisciplinary, interdisciplinarity, and transdisciplinarity, which can be led at the collective as well as the individual level. Multidisciplinary entails the combination of various disciplines to study a complex subject, with each discipline remaining confined within its own boundaries. Limited dialogue occurs between scholars as disciplines are merely placed side by side (Kleinpeter, 2013). On the other hand, interdisciplinarity involves a connective approach among disciplines to study a complex subject in groundbreaking ways. This approach necessitates the exchange and integration of knowledge, tools, and perspectives between different scientific fields (Klein, 2010). Thirdly, while transdisciplinarity can refer to a philosophical endeavor to unify knowledge, it is commonly understood as the collaboration between science and society, aiming to generate both knowledge and action to tackle complex and challenging problems (Funtowicz & Ravetz, 1993; Lawrence, 2015). In this paper, we will focus on interdisciplinarity within the academic sphere.

This article is situated within sociology of science and the broader field of Science and Technology Studies (STS), which recognizes knowledge as not just a cognitive endeavor but also influenced by social, cultural, material, economic, and political factors (Felt et al., 2017). While the section about the merging approach draws examples from the scientific literature, the section about the expansionistic approach draws on a range of sources including scientific literature, archival

materials, press articles, and interview excerpts. The primary and secondary literature are utilized to showcase theories, models, and debates surrounding urban science. The second source of data consists of written and audiovisual archives, such as the town conferences and the Bulletin of the Santa Fe Institute, which has previously used to communicate research conducted by its members until its discontinuation in 2014. Some press articles were consulted to capture explicit statements about urban scientists' perspectives on science. As for the interviews, five were conducted with three major urban scientists, while additional 21 were conducted with other quantitative geographers using computational and mathematical tools in Paris (Géographie-cités research center – Sorbonne Paris 1-CNRS) and London (Centre for Advanced Spatial Analysis – University College London).

Two different approaches to interdisciplinarity

This section situates the problem of asymmetric interdisciplinarity at the expenses of social sciences in a broader context. Then it justifies the choice of the terms “expansionistic” and “merging” to distinguish between the two opposing approaches to interdisciplinary endeavor.

Asymmetric interdisciplinarity

An article recently published in the *Proceedings of the National Academy of Sciences (PNAS)* – a journal in which editorial board members specializing in social sciences possess substantial expertise in quantitative methods or natural sciences – suggests that “social science is entering a golden age, marked by the confluence of explosive growth in new data and analytic methods, interdisciplinary approaches, and a recognition that these ingredients are necessary to solve the more challenging problems facing our world” (Buyalskaya et al., 2021). The authors of this perspective commend the increasing prominence of studies and funding dedicated to research that combines social sciences with natural and engineering sciences. While defining interdisciplinarity

as the “active collaboration among scientists with different training,” they aspire to establish a “truly unifying framework” or a “*lingua franca*” that “will need to cut through the technical jargon specific to any one field of origin in order to be widely accepted and used” (Buyalskaya et al., 2021, pp. 1–2). However, what does this *lingua franca* comprise? After emphasizing the intellectual “humbleness” required for interdisciplinary work, the authors argue that this common language should be composed of the “best” theories available in the social sciences. In particular, they propose using models of coevolution between culture and genetics for anthropology, applying neuroscience to political science for the study of ideology, employing neoclassical theories of market equilibrium and actor rationality for economics, utilizing laboratory experimental methods for psychology, and incorporating network analysis models for sociology. This list unequivocally shows that, similar to the other positivistic projects of “strengthening” the “soft” sciences, the so-called “golden age of social science” does not encompass classic qualitative and quantitative methods and disciplines from humanities, but rather aims at excluding them from the scientific enterprise. This example sets the stage for the description and critical discussion of the expansionistic boundary work.

Four types of boundary work

In light of the STS take that informs this article, the choice of the terms to qualify the “expansionistic” and the “merging” boundary works does not only reflect the epistemic, but also the sociopolitical dimension of interdisciplinarity. In this section, I will firstly define and justify these terms; secondly, I will briefly explain why alternative options have been discarded.

The term “expansionistic” refers to the second form of “boundary work” as it has been defined by American sociologist of sciences Thomas Gieryn (Gieryn, 1999). For him, the credibility of science is established through “credibility contests,” referring to situations where scientists confront other scientists or actors in various arenas (academic, legislative, judicial, entrepreneurial, media, etc.), with the goal of defending their own interests and objectives against opponents. These struggles are

contingent and rhetorical, and researchers employ different elements depending on the context, including arguments of objectivity, efficiency, accuracy, reliability, authenticity, predictability, sincerity, desirability, and even tradition. These struggles manifest as boundary work, which covers all the behaviors that researchers deploy in the frictions within or at the borders of the scientific world. Winning a credibility contest grants epistemic authority, which is “the legitimate power to define, describe, and explain bounded domains of reality” (Gieryn, 1999, p. 1). By drawing boundaries between “science” and “non-science,” or between “good science” and “bad science,” scientists create cultural maps of science “surrounded by less believable or useful terrain” (Gieryn, 1999, p. 4). According to Gieryn, boundary work can take three distinct forms. “Expulsion” occurs when multiple epistemic authorities compete for legitimacy in discussing a particular phenomenon and proposing the best analysis of it: “Real science is demarcated from several categories of posers: pseudoscience, amateur science, deviant or fraudulent science, bad science, junk science, popular science” (Gieryn, 1999, p. 16). The second form, “expansion,” arises when actors attempt to exclude certain ontological domains from the influence of other less reliable and relevant epistemic authorities, such as religion, politics, astrology, or common sense. The third form of boundary work aims to “protect the autonomy” of scientists from actors from other social realms who, by using science to serve their own interests, risk compromising its resources, both material and symbolic. As for the case of urban science described in the next section, the term “expansionistic” obviously comes from the second kind of boundary work described by Gieryn.

In order to portray the positive aspects of interdisciplinarity in the realm of computational social sciences, I align with Gieryn’s classification and introduce an additional category. This fourth type of boundary work diverges from highlighting conflicting dispositions. In the chosen examples, boundaries are not subject to dispute but rather fused in different degrees. When it comes to naming this approach, other conceivable terms do not appear to be as accurate as “merging.” Indeed, “integration” emphasizes seamless unity and coordination, while “fusion” implies the generation of a novel discipline through profound amalgamation of two existing ones. However, even productive

interdisciplinary efforts do not always result in the complete transformation of original components or the creation of entirely new fields. On the contrary, the term “combination” involves arranging elements without necessarily articulating them, yet interdisciplinarity as intended here surpasses mere juxtaposition of methodologies. The concept of “merging” holds the advantage of suggesting the concept of entities coming together while retaining certain distinct aspects, producing something relatively new at varying levels of science (method, theory, discipline, results).

Now, in order to better justify the choice of the expansionistic and merging duo, I will elucidate the rationale behind my decision to disregard an alternative dichotomy I had considered in a prior version of this paper. It opposes “imperialism” to “creolization.” The former term refers to the dominance, leadership, or influence of one group, state, or ideology over others within a particular context. The latter term was famously coined by Martinican poet Édouard Glissant (Glissant, 1997) and refers to the process of cultural mixing and hybridization that occurs when different cultures come into contact and interact with one another over an extended period. Albeit evocative, this dichotomy has been dismissed for three key reasons.¹ Firstly, both imperialism and creolization suppose a pre-existing context of colonization, whereas sometimes expansion efforts are just tentative. Secondly, while imperialism is a deliberate endeavor, creolization is more akin to an unconscious social phenomenon than a political agenda. Thirdly, the term imperialism can be confounding due to its multifaceted usage in history, sociology and the philosophy of science. There are indeed two main ways to understand it: geopolitical and epistemic. In the first case, it refers either to historical imperialism and the role that sciences have played in colonization (Basalla, 1967; Elshakry, 2010; Raj, 2007), or to various forms of contemporary scientific domination in North-South relations within the academic world, conservation programs, or medical testing (Budowski, 1975; Popov et al., 2021; Tucker & Makgoba, 2008; Wilmshurst, 1997). In the second case, imperialism is used as a metaphor to denounce the dominance of one scientific approach over others (Mäki et al., 2017) – in which case we can distinguish between those who criticize it (S.

¹ I particularly thank computational sociologist Antoine Houssard for his insights on this matter.

Clarke & Walsh, 2009; Dupré, 1994; Kirchhoff, 2019) and those who believe it is partly legitimate (Fumagalli, 2018; Mäki, 2013). Thus, the concept of imperialism is difficult to define, it raises debates, and does not neatly fit certain expansionistic scenarios where domination might not currently be present but is still being actively pursued.

The expansionistic boundary work

The expansionistic approach aims at grabbing the usual ontological domains of other disciplines and to state their greater legitimacy in studying them. In the case of urban science, it denotes the inclination of its proponents to impose the methods, concepts, and values of physics, computer science, and neoclassical economics onto social sciences to understanding city dynamics. The choice to focus on urban science as a case study is context-specific, as it emerged during my doctoral research on complexity sciences² in Europe and the United States (AUTHOR, DATE). During my researches at complexity institutes in Paris (France) and Santa Fe (New Mexico, USA), I encountered several individuals engaged in quantitative and modeling approaches to spatial issues. This led me to delve into their scientific practices, ontological beliefs, and normative perspectives (AUTHOR, DATE). Among these scholars, some were geographers who became complexity modelers through self-education with statistics and computer programming. This was the case with the Géographie-cités lab in Paris (Sorbonne, CNRS) (Cottineau & Pumain, 2022). Others were physicists who transitioned into a new form of quantitative geography known as “urban science” (Bettencourt et al., 2007), which partly originated at the Santa Fe Institute – cradle of the complexity sciences (Waldrop, 2019) and often described in journalistic and self-promotional

² This field can be described as an interdisciplinary and transnational association of specialties, whose aim is to computationally model and simulate natural and social “complex systems.” These are defined as big ensembles of heterogeneous elements whose interactions produce emergent properties that are not deductible from their microscopic level. Because of the generality of this notion, basically everything from ecosystems to cities, from epidemics to financial markets can fall within it (Mitchell, 2009). The field has been launched in the mid-1980s by a group of senior physicists from the Los Alamos National Laboratory and other American universities, with the purpose of applying computer and interdisciplinarity to life and social sciences to make them “more scientific.” Alongside a few other theories derived from physics, “complexity” has become one of the most popular scientific domains in the past forty years, arising interest in some social scientists (Castellani & Hafferty, 2009; Taylor, 2003; Thrift, 1999; Urry, 2005).

accounts as the “Meccah” of interdisciplinarity. Nevertheless, this paper does not engage directly with the extensive and longstanding debate on quantitative geography³ that has been ongoing for at least fifty years, albeit urban science and other numerical approaches to geography can contribute to fuel it (M. Clarke & Wilson, 1989; George, 1952, 1976; Kitchin, 2020; O’Sullivan & Haklay, 2000). In this section, urban science provides illustrations of the expansionistic approach through three strategies: 1) the neglect and exclusion of social science knowledge about the cities, 2) the transfer of tools from “hard” to “soft” sciences resulting in oversimplification of the social complexity, and 3) the naturalization of social aspects which depoliticizes discourse about them. As we will see, in this kind of boundary work the resulting knowledge may suffer from triviality, reductionism, and/or incorrectness.

Neglect and exclude

When discussing the epistemic project of the Santa Fe Institute (SFI), physicist-chemist George Cowan, one of the institute’s founders and its initial president (1984-1991), shares statements that highlight the mindset of the new field of complexity sciences. Without distancing himself, he recounts an example where one of his friends chooses not to read articles lacking equations: “One of my friends says he judges papers by the ratio of narrative to equations. If he doesn’t find a single equation, he doesn’t read the paper” (SFI, 2000, p. 3). Nobel laureate in physics, Murray Gell-Mann, another founding member of the SFI, addresses the disregard shown by his fellow physicists toward behavioral sciences like psychology. He advocates for attempting to make these disciplines more scientific rather than dismissing them with disinterest: “Even if I agreed [with my colleagues

³ Quantitative geography is a branch of human geography that was established in the 1950s through the efforts of Swedish, Anglo-Saxon, and French scientists (Adams, 2001; Berry, 1993; Berry & Pred, 1965; Clerc et al., 2019; Cuyala, 2014; Johnston & Sidaway, 2015; Robson, 1973; Varenne, 2017). Their project aimed to revitalize their discipline by incorporating theories and tools from the natural and engineering sciences to model the socio-spatial organization and evolution of cities. Their analytical techniques include descriptive and inferential statistics, as well as gravity, stochastic, and deterministic models. Quantitative geography should not be confused with physical geography (a branch of the natural sciences), urban computing (ICT and big data applied to the study and development of “smart cities”), or geomatics (dedicated to the collection, storage, and processing of geographical data). The field is composed of various currents, among which the complexity stream has internal heterogeneity itself (Albeverio et al., 2007; Batty, 2009; Bettencourt et al., 2010; Crawford et al., 2005; Heppenstall et al., 2011; Johnson et al., 2017; Lane et al., 2009; O’Sullivan et al., 2006; Portugali et al., 2012; Pumain, 2020; Rozenblat et al., 2018).

at CalTech] that subjects like psychology are not yet sufficiently scientific, my preference would be to take them up in order to participate in the fun of making them more scientific” (Gell-Mann, 1994, p. 119). Complexity scientists clearly perceive themselves as rescuers of “pre-scientific” knowledge, which they aim to transform into “true science” (SFI, 2002, p. 8, 2004, pp. 11–12). Consequently, this mission involves devaluing anything that lacks quantitative and mathematical elements.

Urban scientist Geoffrey West, former physicist at Los Alamos National Laboratory and seventh president of the SFI (2005-2009), shares similar positivist beliefs by seeking to produce a general theory of urban development in order to launch a new “science of cities.” When confronted with deviations from the patterns he observes in city dynamics, he tends to diminish their significance by asserting that “Every fundamental law has exceptions. But you still need the law or else all you have is observations that don’t make sense. And that’s not science. That’s just taking notes.”⁴ This posture brings to mind the well-known quote by physicist Ernst Rutherford: “All science is either physics or stamp collecting” (Birks, 1963). During our interview, West’s colleague at the SFI, Luis Bettencourt, expressed his views on cultural geography, describing it as a “sort of postmodern version of Anthropology,” whose proponents “tend to associate space with cultural values and traditions etc.” He admitted to having limited interaction with these scholars because they have a “little less analytical” approach compared to his own. Although he found their work “interesting in some ways,” he found “it’s more difficult [for him] to talk to them” (interview with Luis Bettencourt, 28.09.2016). In an interview with the *New York Times*, West recounts that at the beginning of his research in geography, he “didn’t want to be constrained by the old methods of social sciences” and grew impatient with the “unconstrained speculations of architects.” He also explains that he views urban theory as a field lacking principles, comparable to “physics before Kepler.” He concludes that he wanted to begin his research in geography “with a blank page, to study cities as if they had never been studied before. He was tired of urban theory – he wanted to

⁴ https://www.nytimes.com/2010/12/19/magazine/19Urban_West-t.html.

invent urban science.”⁵

In the light of what precedes, it becomes apparent that not only are they unfamiliar with social science research on cities, but that urban scientists also openly discredit it. This results in a triple exclusion. Theoretically, they disregard disciplines such as cultural geography, sociology, history, and anthropology within their scientific articles. In terms of publication, they exclusively publish in journals like *Nature*, *PNAS*, *Physical review D*, which keeps them confined to the “shadow of physics” and of natural sciences, as highlighted by sociologists Yves Gingras and Christophe Schinckus in their paper on econophysics – another subfield of complexity sciences that aims to “revolutionize” economics but struggles to be published outside of physics journals (Gingras & Schinckus, 2012). In terms of funding, urban scientists easily attract attention and support from corporations, foundations, and smart city municipalities. While they lack recognition from professional geographers in academic circles, they are prioritized over more relevant approaches from the social sciences by these actors. All in all, one cannot claim urban scientists promote real interdisciplinary engagement. In Gieryn’s terms, the work of SFI complexity specialists in general, and of urban scientists in particular, aims at the expulsion of more traditional approaches, when they devalue previously established knowledge about cities. It is expansionistic when they assert the superiority of their approach over competing ones to make sense of cities. While the specific case of urban science may not pose a significant threat to professional geographers, expulsion and expansion as forms of boundary work can have detrimental effects, as seen for instance in the case of “evidence-based economics,” where the dominance of randomized control trials excludes more “qualitative” studies from economic journals (Bédécarrats et al., 2020). From an anti-positivist stance, it is worth noting that quantitative components should be regarded as tools among a variety of others and should not be pursued as goals in and of themselves. Also, a legitimate question arises: can we completely do away with a discussion about anthropological invariants? Certainly not. That is why it is important not to grant the monopoly of discourse on the general characteristics

⁵ https://www.nytimes.com/2010/12/19/magazine/19Urban_West-t.html.

of the human species to the positivistic approaches such as these. Recent works in ethology and sociology show that a truly interdisciplinary work of synthesis between natural and social sciences about anthropological universals can be pursued in fruitful and interesting ways (Lahire, 2023; Waal, 2022).

Transfer and reduce

The SFI bulletin of 1994 unequivocally presents the expansionistic agenda of complexity sciences, stating that “Cowan’s vision has been to apply the quantitative tools of the physical sciences, such as mathematics, to the social sciences” (SFI, 1994, p. 3). The aim of this approach is to uncover the fundamental laws governing complex systems, which cities will later become another illustration of. According to SFI urban scientists accounts, the “science-based” analyses they conducted in the early 2000s enabled them to detect a number of regularities and identify an initial set of “laws” of cities (Bettencourt et al., 2010, p. 912). In one of his books, British planner Michael Batty, who shares a similar perspective with his counterparts at the SFI, stated that the laws discovered by him and his colleagues “may not be laws in the accepted sense of the term in the physical sciences, but they reveal strong regularities that seem to persist in time and space” (Batty, 2017, p. 38). These researchers often employ scaling laws to describe recurrent properties of urban centers. Scaling laws refer to a mathematical relationship that describes phenomena exhibiting scale invariance, where the properties remain the same regardless of the observer’s level of analysis. Essentially, the goal of West and Bettencourt at the SFI has been to identify, through mathematical tools, regularities in the relationships between cities. By applying scaling laws to large databases many of which are freely accessible online (about transportation networks, distribution of schools, gas stations, patent numbers, etc.), they point at what makes two megalopolises like New York and Delhi more similar to each other than to medium-sized American and Indian cities. Urban scientists achieve this by relating variables such as population size to other factors like infrastructure or trade activities. According to West and Bettencourt, the proportions of basic needs such as housing,

electricity, or water hardly vary, regardless of the country, while social phenomena increase anywhere at the same rate in relation to demography. In other words, as the population grows, GDP, wages, patents, crime rates, and traffic congestion all increase at a similar pace. However, economies of scale are observed for infrastructure. The SFI researchers argue that if a city's population doubles, the infrastructure it relies on only increases by 85%. These findings – which are highly contestable by the way⁶ – lead West to make a statement to the *New York Times*, revealing his reductionist and empiricist vision that fetishizes data:

“What we found are the constants that describe every city [...] I can take these laws and make precise predictions about the number of violent crimes and the surface area of roads in a city in Japan with 200,000 people. I don't know anything about this city or even where it is or its history, but I can tell you all about it. And the reason I can do that is because every city is really the same.”⁷

Here we see the influence of the belief – characteristic of complexity sciences and chaos theory – according to which the abundant complexity of the world is, in fact, the expression of a limited number of simple laws that need to be uncovered to explain what appears chaotic and impenetrable (Gleick, 2008; Pines, 1988, p. 3; Waldrop, 2019). Complexity researchers denounce the multiplicity of explanations within the social sciences, viewing it as a sign that these disciplines do not qualify as “true” sciences. This criticism can be traced back to the positivist ideals of the Vienna Circle, which envisioned a singular scientific method akin to that of physics, deeming any alternative approach as illegitimate (Knorr-Cetina, 1999). Ironically, this perspective causes specialists in urban

⁶ As Irish geographer Robert Kitchin told me in an interview about his criticism of urban science, “Some cities might be around 40% and some cities upper. Because you are taking away the variation by aggregating numbers, you can't see that. What are the standard variations? Or do they just conveniently forget them and say, ‘OK we found a power law?’ Second thing, even if there is a relationship, so what? What do you do with that information? Are they saying that there is now a highly formulate way in which then you can go planning about future cities in which you say, ‘If you do this, then you have to add this, this and that? And in doing that, we can kind of ignore the local conditions, the local culture, etc.?’ It just seems to be an analysis that sets outside the context” (interview with Rob Kitchin, 08.07.2021).

⁷ https://www.nytimes.com/2010/12/19/magazine/19Urban_West-t.html.

and complex systems to overlook the intricacies of social systems and undermines the collaborative nature of interdisciplinarity, which seeks cooperation between different forms of knowledge.

While scientists and philosophers recognize that scientific modeling (whether discursive or mathematical) tends to seek out regularities and simple mechanisms to explain complex phenomena (Ylikoski & Aydinonat, 2014), urban scientists can be criticized for oversimplifying the evolution of cities, ignoring counterexamples, and producing incomplete or even unusable models (Kitchin, 2020). If it is normal to expect from a social scientist who aspires to create quantitative models that he or she dedicate significant effort to coding or mathematics (Banos, 2016), any quantification of society must start from social sciences if it does not want to produce mutilated or useless knowledge (Busch, 2017). Human societies are heterogeneous, changing, complex, and reflexive; human beings have agency and are influenced by epochs, places, cultures, and social orders; which is why sociology, anthropology, history, economics, and social psychology among others are hermeneutic sciences, which produce interpretative causal accounts. Contrarily to the positivistic criticism, the theories and empirical findings of the social sciences are solid, albeit they are mostly qualitative, very diverse and seemingly contradictory. While physicists generally seek theoretical unification (Cat, 1998), the theoretical pluralism of the social sciences is useful for seeing the world in a prismatic way, as each approach illuminates something that the others leave in the shadows (Pestre, 2012). By seeking universal determinants of urban development and formalizing them mathematically, urban scientists fail to consider the fact that economies of scale and migration flows, for example, have long been theorized by the social sciences (Hanson, 2001; Rosenthal & Strange, 2004; Wright & Ellis, 2016). Geographers – as well as demographers, economists, and anthropologists – offer multiple interpretative frameworks for local, regional, and cross-border flows of human mobility, invoking economic, demographic, cultural, and other factors (Baykara-Krumme & Fokkema, 2019; Kourtit et al., 2021; Wang et al., 2016). Moreover, multiple theories have circulated since at least the 1950s to explain urban growth. Hydraulic theories (related to agricultural irrigation), economic theories (related to the development of exchange networks),

military theories (related to the need for protection against external contingencies), and politico-religious theories (related to the concentration of temporal and spiritual power of elites in a single location) alternate and in the end complement each other in accounting for the increasing size of cities (Pacione, 2009, p. 39). All in all, most geographers and planners, despite the different schools of thought they may belong to, generally recognize the multifactorial nature of spatial phenomena and contextualize them within long-term historical perspectives. All of this is reduced by the SFI's urban scientists to the fundamental properties of the city seen as a natural system. In doing so, they overlook culture, politics, economy – in short, everything that constitutes the social identity of a city.

Naturalize and depoliticize

So far we have seen that urban scientists apply tools derived from natural sciences because they see them as the best way to grasp universal urban trends. However, in order to search for such regularities, they must first presuppose them. This section highlights that, according to their view, the physical characteristics of cities hold greater importance than sociopolitical factors. As a consequence, they naturalize their view of the social world and their implicit political preferences.

Let us take a concrete example from one of their articles, in which urban scientists at the SFI establish a mathematical formula relating a series of elements:

- the population of a city (N),
- material resources and social activity (Y),
- three possible dynamics of urban centers (growth, decline, stagnation) (β),
- the quantity of resources required to sustain one inhabitant in the city (R),
- and the quantity of resources required to add one more inhabitant (E).

Figure 1 shows the equation used to calculate the rate of urban growth, where a normalization

constant (Y_0) allows them to model random phenomena. The central variable is represented by β , whose implications are explained in Figure 2. According to the reasoning behind it, if growth follows the so-called “biological” logic of economies of scale, which eventually decreases in adulthood (β less than one), the city’s demographic rate tends toward a plateau and then decline (organisms experiencing a decrease in their pace of life as they grow). On the other hand, if it follows a “sociological” organization of information and resource creation, its growth can continue indefinitely (β greater than one), provided that innovation occurs in increasingly shorter cycles.

$$N(t) = \left[\frac{Y_0}{R} + \left(N^{1-\beta}(0) - \frac{Y_0}{R} \right) \exp \left[\frac{-R}{E} (1 - \beta)t \right] \right]^{\frac{1}{1-\beta}}$$

Figure 1. Equation of urban growth rate. Caption: N represents the population of a city, Y denotes its material resources (energy, infrastructure) or social activity (wealth, pollution), β represents three possible general dynamics of urban centers (growth, decline, stagnation), R is the quantity of resources needed to sustain one inhabitant, and E is the quantity of resources needed to add one more. Finally, Y_0 is a normalization constant (Bettencourt et al., 2007).

Table 2. Classification of scaling exponents for urban properties and their implications for growth			
Scaling exponent	Driving force	Organization	Growth
$\beta < 1$	Optimization, efficiency	Biological	Sigmoidal: long-term population limit
$\beta > 1$	Creation of information, wealth and resources	Sociological	Boom/collapse: finite-time singularity/unbounded growth; accelerating growth rates/discontinuities
$\beta = 1$	Individual maintenance	Individual	Exponential

Figure 2. Explanation of the variable β . “Individual maintenance” refers to stagnation. The voice “Optimization, efficiency” refers to a capitalism that does not innovate enough. The voice “Creation of information, wealth and resources” corresponds to the “right” pace of innovation (Bettencourt et al., 2007).

The SFI bulletin provides an explanation for the meaning of these equations as follows:

“To grow indefinitely, a city has to periodically reset its growth rate. Such ‘resetting’ can come from innovations that revitalize the economy, or from outside factors, such as shifts in immigration. The pattern that an ever-growing city falls into is one of successive growth cycles – each one shorter than the last as the size of the city increases. ‘You’re on this treadmill and you’ve got to go on making these changes, these innovative changes, faster and faster because if you don’t you’ll stagnate and collapse’, West says” (SFI, 2008, p. 8).

The mathematical detection of physical regularities pursued by urban scientists does not rely on a static view of urban history. From their perspective, the evolution of cities depends, on the contrary, on innovation and competition – factors capable of explaining the constant dynamism of cities on their own. This may seem paradoxical since innovation is generally associated with creativity and surprise, while here it is subject to a nomothetic, deterministic and reductionist thinking.⁸ However, the contradiction is only apparent because in the models of urban scientists, innovation has a unidirectional causality that diffuses from a few fundamental poles to the rest of the urban system. This means that determinism and innovation can coexist to the extent that the latter is interpreted as a sociotechnical factor constrained by physical determinants. Is the urban science promise of unbiased science fulfilled? Or does this sociotechnical determinism have a political color? In other words, what underlying historical perspective and normative stance inform its models?

Consistent with the neoclassical economics from which they often draw inspiration, my interviewees make a highly political observation about the purpose and destiny of cities when they grant urban centers the possibility of infinite growth. In this perspective, “what you do with policy is to drive these loops [...] You cannot break those rules or build them anew but you can drive them

⁸ The debate surrounding determinism has engaged scholars from all sides in philosophical discussions for centuries due to its significant theoretical and political implications (Hofer, 2023; O’Keefe, 2021; Pomian, 1990). Geography has not been spared from this debate; on the contrary, it has been the site of fierce exchanges on this issue, both before and after the emergence of “complex systems” approaches in geography (Barnes, 2010; Dollfus, 1985; Fotheringham, 2006; George, 1952; Kitchin, 2020; Labinal, 2019; Marshall, 2006; Mattern, 2013; Poon, 2005; Sheppard, 2001).

in the right or wrong direction” (interview with Luis Bettencourt, 28.09.16). For Bettencourt, the role of a political decision-maker is comparable to that of a surfer: “it’s like catching a wave, the wave is already there but you can go faster if you know how to catch it. If you are against it it’s not going to work.” According to West, the scope of action for administrations is indeed limited: “My interpretation [...] is that where that cycle [of economic growth] ends up might depend upon whether you have a city with a good administration in place, but the general trend and the coarse-grained scale of it is probably determined for you” (SFI, 2008, p. 8).⁹ Sometimes quantitative endeavors in the social sciences are criticized for providing an “a-social” description of society (Ollion, 2018, p. 83), but here naturalization and depoliticization of urban dynamics are accompanied by an implicit and yet very precise interpretation of society. Despite their intention to make geography more “objective,” urban scientists shape through their work an urban ontology that views cities as decentralized and competitive entities, in which political decision-making plays a minor role compared to physical constraints and sociotechnical innovations. While aiming to be ideologically neutral, they end up presupposing two essential elements of liberal capitalism – competition and innovation – as the archetypal functions of human communities, regardless of the countries and time periods under study. Furthermore, they use “science” to legitimize the normative objective of infinite growth: “‘Should a city have a finite size or should it grow forever? How should it grow? You would argue about it forever if you hadn’t measured’, Bettencourt says” (SFI, 2008, p. 6).

Given these analyses, what political considerations can be drawn from our case study? Is there a risk that the work of urban scientists ends up supporting liberal projects, even unintentionally? Irish geographer Robert Kitchin – an active critic of urban science – answers affirmatively, stating that this risk exists “to the extent that [what urban scientists do] is intended to be apolitical” (interview with Robert Kitchin, 08.07.21). Indeed, when asked about their expert stance, these researchers

⁹ This is not specific to SFI urban scientists, because the quantitative geographers from the Parisian laboratory have a similar interpretation of the evolution of cities that they simulate through agent-based modeling. The researchers of this team build in their digital models a certain number of “urban functions” (territorial, economic, political) in order to simulate the coarse-grained evolution of a system of cities over long periods. In this context, innovation is modeled as an object that cities can exchange among themselves (Rey-Coyrehourcq, 2015).

describe science as a neutral knowledge “supposed to tell [...] how things work,” leaving the responsibility of decision-making to political entities, NGOs, and businesses (interview with Luis Bettencourt, 28.09.16). The critique of this position is well-known within the sociology of sciences. When scientists pretend to be neutral and support the “linear model” of expertise – called “speak truth to the power” (Jasanoff & Wynne, 1998) – they may unconsciously reproduce the status quo at best or conceal vested interests at worst (Oreskes & Conway, 2011). Furthermore, urban scientists contradict themselves because, as one of them admits, this “fundamental science” is carried out within a “broad framework of choices” characterized as follows:

“It’s a bit like Liberalism with a big L, not the political liberalism, but the idea that we should create societies which have a lot of choice and agency and a lot of their basic needs are taken care of and that [...] the pursuit of happiness is a fundamental right of everybody. You can say that that’s political but I think it’s also quite consensual in terms of that being a good thing and that science can tell you a little bit about the conditions that generate more that than others” (interview with Luis Bettencourt, 28.09.16).

Beyond the fact that what is “consensual” is no less political, the interventions made by these researchers in scientific, media, and political arenas are rich in more or less explicit prescriptions. These researchers do not hesitate to provide decision-making assistance to the administrations of “smart cities,” supporting them through written reports for the White House,¹⁰ popular books (West, 2017), and programmatic articles (Batty et al., 2012). For these reasons, Kitchin has written that “urban science needs to openly acknowledge its contingencies, shortcomings and inherent politics and to recognize that it does not reflect the world as it actually is, but rather actively frames and produces the world” (Kitchin, 2016, p. 11). An observation that we can only endorse. Because by presenting one methodology and one normative approach alone, defined as “objective,” urban

¹⁰ <https://obamawhitehouse.archives.gov/blog/2016/02/23/pcast-releases-technology-and-future-cities-report-president>.

scientists erase methodological and ideological pluralism, subtly naturalize their academic posture and political preferences, and minimize the role of power struggles in the history of cities.

Geographers overlook or criticize urban science contributions for three key reasons. Firstly, urban scientists fail to recognize the value of cumulative results in the social sciences, which visibly leads to a dialogue of the deaf (Kitchin, 2016, 2020). Secondly, social scientists perceive the output of complexity sciences as either trivial, useless, or misleading due to the reductionist nature of their mechanistic models (Israel, 2005; Talbott, 2002). Thirdly, urban scientists operate within different funding channels and expertise frameworks than those typically employed by social scientists, aligning them more closely with the business realm than the academic sphere (Baker, 2022; AUTHOR, DATE). It is therefore time to define the parameters of a more reflexive, symmetrical, and productive approach to interdisciplinary collaboration between the social, natural, and engineering sciences. This is the object of the next and last section about the merging boundary work.

The merging boundary work

The preceding section has elucidated the components of an expansionistic boundary work by exemplifying it through the case of urban science frameworks, findings, and normative stances. However, it is crucial to recognize that there is no fatalism in the relationship between these elements. In fact, the methods of complexity sciences have also yielded richer, more reflexive and more denaturalizing qualitative-quantitative approaches in digital humanities and computational social sciences. These approaches are characterized by a deep integration of numerical tools with established social theories and often by the collaboration between physicists, mathematicians,

computer scientists and social scientists (Chateauraynaud & Chavalarias, 2017; Edelman et al., 2020; Raimbault et al., 2016; Venturini et al., 2015; Vertesi & Ribes, 2019). In a comprehensive analysis of this domain recently published in the *Annual Review of Sociology*, the authors begin by defining it as “an interdisciplinary field that advances theories of human behavior by applying computational techniques to large datasets from social media sites, the Internet, or other digitized archives such as administrative records” (Edelman et al., 2020, p. 24.2). Importantly, this definition is performative in nature, as it not only describes the field but also prescribes its scope and focus – the authors position themselves explicitly on this point. Originally, the term was used to describe the application of agent-based modeling to the social sciences by complexity specialists associated with the SFI in the 1980s and 1990s (Dean et al., 2000; Epstein & Axtell, 1996). Subsequently, it gained prominence through the work of other complexity scientists who specialized in networks and big data (Lazer et al., 2009; Törnberg & Uitermark, 2021). However, Edelman and colleagues explain that “although many of these studies apply elegant theories from physics and mathematics to analyze collective dynamics such as crowd behavior, they are largely disconnected from social science theory” (Edelman et al., 2020, p. 24.2). But the examples cited in this section have been carefully selected because they stand apart from this tendency by effectively intertwining social theory with novel digital tools.

Acknowledge and articulate

As Edelman et al. (2020) remind us, for interdisciplinarity to hold greater value in the realm of social sciences, it is crucial that it is grounded in social theory. After having criticized the reductionist, simplistic, and depoliticizing approach that may derive in interdisciplinary settings from natural and engineering sciences, their article focuses solely on studies that, in some way, adhere to what I propose to term as the “merging” boundary work. I refer the reader to Edelman and colleagues’ paper to discover multiple examples coming from several fields of computational social sciences (culture, gender, science, etc.). Here I will base my case study on a group of French

sociologists and modelers who sought to integrate network simulations with the 19th century French sociologist Gabriel Tarde's theory of monads (Latour et al., 2012). This theory posits that the social fabric is constituted by distinct individual entities, each embodying a singular perspective and playing a role in shaping social interactions through processes of imitation and variation.

The question they pose revolves around the fundamental distinction between the individual and aggregate levels of social life. This has traditionally led social science scholars to neatly separate micro and macro levels, raising inquiries about their relationship and the emergence of macro features from micro interactions. However, according to Latour and colleagues, this division has obscured the central phenomenon of understanding stronger and longer-lasting associations between actors. In their article, the authors explore how digital traces in newly available databases can reshape conventional questions of social order. They examine an alternative social theory – Tarde's monadology – which challenges the assumption of two distinct levels – what they call the “two level standpoint” or 2-LS – and provocatively suggest that complexity resides more in the elements than in the aggregates. They argue for a “one level standpoint” or 1-LS that navigates through overlapping entities – termed “monads” or “actor-networks” in Latour's terminology – to account for persistent features of social order. According to them, the proliferation of digital databases provides an opportunity to redefine the problem of the relationship between the parts and the whole. Their proposal can be seen as an attempt to transcend the longstanding debate in human and social sciences between methodological individualism and methodological holism (Giry, 2018; Heath, 2020; Zahle, 2021). Instead of favoring one over the other, Latour and colleagues strive to reconcile the two perspectives by demonstrating that, by focusing on individuals, analysts can gain insight into the larger whole. However, note that this whole is inherently limited and fragmented, as each actor in a society possesses only a subset of the holistic elements necessary for a complete understanding. This extract illustrates the central point of their proposal:

“What does it mean to follow a collective phenomenon in the 1-LS navigational procedure?”

When one observer begins to quickly transform a clickable dot [in a network cartography] into a fully defined monad by listing its attributes, he or she is *already* dealing with a collective phenomenon (though in a sense that does not resemble the 2-LS definition of collective). The observer is gathering successive items and *encircling* them *inside* what has become the proper name of a specific monad. As such he or she is dealing with an 1-LS collective, or better, a *collecting* activity: it is *this* monad that gathers, assembles, specifies, grasps, encapsulates, envelops those attributes in a unique way” (Latour et al., 2012, p. 608).

Certainly, one can hold varying levels of appreciation for Tarde’s monadology and the theoretical propositions presented in Latour and colleagues’ article. However, one thing is undeniable: their work acknowledges and articulates social theory and digital tools without uncritically importing a mechanistic framework from the natural or computer sciences into the humanities. At the same time, the use of digital tools prompts innovation in the field of social theory by providing an original solution to the ongoing debate between individualist and holistic methodologies. While it is essential to start from the perspective of individuals, these inherently possess a general view of society. Consequently, social scientists can gain access to the entire social context through the compilation of various individuals’ perspectives, each of which are at the same time holistic and partial.

When pursued at an individual level, a symmetrical approach in interdisciplinarity often manifests as a merging endeavor too, but it may take different forms. Single researchers from one field, seeking to combine their expertise with that of another discipline, have at least three options. Firstly, they can engage with unfamiliar subjects from another field using their own tools, capitalizing on the element of novelty. Secondly, they can delve into unfamiliar subjects after acquainting themselves with specialized literature generated by other disciplines on the topic. Thirdly, they can leave their office and seek out nearby colleagues who specialize in that specific field to engage a discussion, which can allow them test their hypotheses and give rise to a transformative exchange.

Nevertheless, theory and tools are not the sole aspects to be considered. In terms of funding, there is often a discrepancy between the rhetoric supporting interdisciplinarity and the actual conditions for its implementation (Banal-Estañol et al., 2019; Benz & Rossier, 2023; Prud'homme & Gingras, 2015). However, in both the United States and Europe, public agencies are increasingly dedicating additional funding to support truly interdisciplinary research. This trend is evident in the project funding opportunities provided by institutions such as the National Science Foundation (NSF), the European Commission (Horizon, ERC), and, in the case of France, the National Research Agency (ANR) and the National Scientific Research Center (CNRS). Today, these funding channels systematically include interdisciplinary axes in their calls for project. A notable example within the conglomerate of research centers where I work in Paris (UAR 2276 Pouchet, CNRS) is the project “ScientIA,” which is funded by the ANR and led by a team consisting of a mathematician, a sociologist, a philosopher, and a physicist.¹¹ This team aims to analyze the introduction of “Artificial Intelligence” in academic and industrial research using an interdisciplinary approach. The project focuses on studying the impact of AI on research, including epistemic transformations, changes in scientific practices, and social perceptions. Three main questions guide the ScientIA project: the mechanisms that facilitated the spread of AI in different research areas, the consequences of AI’s entry into science and research and development (R&D) on scientific cultures and practices, and the social acceptance of AI in science and technology. To address these questions, the team combine computational tools (network science, complex systems methods, AI techniques, and modeling) with social science methodologies (surveys and qualitative interviews). With this background and a merging approach, these colleagues are already producing interesting knowledge about these important subjects of inquiry (Gargiulo et al., 2022). The sociological interpretation of their quantitative results may indeed help them avoid a disembodied approach that simply applies numerical tools to a set of databases, losing sight of actors’ intentions, cultures, and power struggles.

¹¹ <https://cis.cnrs.fr/scientia/>.

In conclusion, interdisciplinarity faces challenges, such as power imbalances between different disciplinary teams, difficulties for individuals trained in interdisciplinary settings to secure subsequent employment, and the fact that interdisciplinary institutions and funding often assume a disciplinary framework and hierarchical structure between disciplines (Prud'homme & Gingras, 2015; Williams, 2012, p. 165). However, despite these obstacles, successful collaborations do occur, both temporary and long-lasting. Facing the complexities of the world, new fields of study indeed emerge all the time and interdisciplinarity is often involved in this process of creation of new social spaces, professional categories, funding sources, and recruitment avenues (Abbott, 2010; Jacobs & Frickel, 2009). In this context, sociologists of science have studied well-known examples of this creative process, such as molecular biology and genetic toxicology (Frickel, 2004; Mullins, 1972). While the creation of a new specialty does not have to be the ultimate objective of interdisciplinarity, it remains an enticing possibility on the horizon of the merging boundary work.

Combine and enrich

Whether on an individual or collective level, adopting a merging approach entails a willingness for cross-fertilization. In this section, I will examine a researcher's combination of digital tools and traditional sociological methodologies (both qualitative and quantitative) to investigate the role of Twitter in political contexts (Boyadjian, 2014). This case study represents an enrichment for the social sciences and corrects the more quantitative approaches that have addressed the same issue. The key message of this section is that while integrating new digital tools into political science enables the field to address emerging phenomena, traditional approaches from the social sciences remain indispensable for computational social sciences to generate relevant knowledge.

In his paper, political scientist Julien Boyadjian explores the role of Twitter as a platform for political discourse and in predicting electoral outcomes. During his PhD thesis, he conducted a study to investigate the correlation between Twitter activity and offline political engagement, as well as the representativeness of Twitter users in relation to the broader population. This study

departs from the theses proposed by Andranik Tumasjan and Brendan O'Connor, which suggested that Twitter could be used as a reliable tool for predicting election results (O'Connor et al., 2010; Tumasjan et al., 2010). Boyadjian employed a combination of the Twitter tracker tool, which analyzed political tweeting activity, and a sociological questionnaire to gather additional data on participants' offline political engagement. This mixed-method approach aimed to provide a comprehensive understanding of the relationship between Twitter behavior and the real-world political involvement. Boyadjian's work shows that a small minority of respondents, comprising political party activists and highly engaged individuals, consistently publish political tweets, regardless of the intensity of political events. These users, labeled as "political junkies," rely heavily on the internet as a source of information and display a unique consumption pattern of news, perceiving it as a civic necessity. They use Twitter as a central platform for commenting and expressing political opinions through information exchanges. These users also tend to have a larger online sociability, as indicated by their significantly higher number of followers. However, the majority of panel participants rarely engage in political tweeting, with high levels of activity occurring only during periods of significant political events. Moreover, sociological characteristics such as gender, age, education level, and profession significantly influence the number and frequency of political tweets. In this regard, Boyadjian's study demonstrates that young, educated, middle class men are the most active. Therefore, Twitter is not representative of the broader population and reveals its predictive capabilities are limited and must be approached with caution.

What can be learnt from this example in view of the merging approach? In the words of Noortje Marres' book on digital methods in sociology, the central concern "is not so much whether or not digital tools are new or old, but whether they can be configured to further develop methods of social enquiry" (Marres, 2017, p. 81). This is precisely why she encourages us to view inquiry tools as interfaces – avenues that offer "an opportunity to engage critically and creatively not only with methods that are prominent in today's digital culture but equally with relevant methodological traditions in social research" (Marres, 2017, p. 110). During the initial investigations of the Internet,

social scientists emphasized its epistemological and ontological uniqueness, contending that fresh methodologies, perhaps even a new discipline, were requisite for its study (Hine, 2000; Jones, 1998; Kozinets, 2002). More recently, some authors have advocated against dichotomizing the “real” and the “virtual” worlds, urging the retention of conventional investigative methods from the realm of social science besides the adoption of new digital means when delving into the Internet (Baya-Laffite & Benbouzid, 2017; Dagiral & Martin, 2017; Pastinelli, 2011). In other words, what media scholars Van Dijck and colleagues have dubbed the “platformization of society” (Dijck et al., 2018) is not merely an opportunity to enhance tools for social sciences inquiry, but also serves as fertile ground for the enrichment and strengthening of computational methods themselves. In the context of interdisciplinary merging endeavors, such as the interaction between sociology and computer science, distinct questions arise for each of these fields, alongside novel questions that their collaboration can illuminate in groundbreaking ways. After all, the whole is more than its parts, isn't it?

Denaturalize and repoliticize

Science and technology studies have consistently demonstrated that both science and technology are far from being neutral, apolitical, or asocial (Jasanoff, 2004). The critique presented in the section about the expansionistic boundary work does not criticize the liberal ideology brought forth by urban scientists as such. Instead, the criticism is directed at the concealment of its normative tenets, highlighting the tendency of urban scientists to disavow any ideological stance in their discourse. The act of naturalizing city dynamics has the consequence of obscuring alternative interpretations. This approach effectively sidelines power struggles and inequalities, resulting in the depoliticization of discussions about cities and limiting the diversity of the admitted perspectives. Now, in contemporary academic settings, social scientists are expected to adopt a reflexive and critical stance toward hegemonic frames. The role of a researcher entails distancing oneself from social norms and personal beliefs to effectively challenge prevailing common sense. Numerous social

scientists globally would likely agree, irrespective of their academic orientation, that a primary mission of their job involves denaturalizing cultural elements that have not yet undergone such scrutiny. It is for them crucial to recognize that power is inherently intertwined with knowledge, and that this is true for themselves too. Attempting to speak from an ostensibly neutral standpoint is, in fact, a form of naturalization. This act represents a power move within the dynamics of boundary work, where arguments serve as weapons in the establishment and protection of disciplinary frontiers. Consequently, the essential goal for us here is not neutrality but rather a commitment to pluralism, acknowledging the inherent subjectivity in scientific pursuits and actively making one's viewpoint explicit.

Let us now go back to complexity scientists at the SFI, expanding our focus beyond urban scientists. As demonstrated in prior works, the fellow researchers of this New Mexican institute have often legitimized capitalism in their works, by equating socioeconomic dynamics with the natural principles governing living systems such as evolution, competition, and adaptation (Baker, 2022; Helmreich, 1998, 2000; AUTHOR, DATE). A diverse group – comprising economists, physicists, computer scientists, sociologists, ecologists, psychologists, and mathematicians – has done this by applying the “complex adaptive systems” perspective to social systems. This approach draws from a narrow interpretation of Darwinian natural selection influenced by Herbert Spencer's social Darwinism. The SFI's complexity scientists assert that any complex adaptive system, in order to survive, must innovate whether genetically, economically, or strategically. Their modeling tools frequently incorporate elements of encoded rivalry, linking evolutionism to both natural and social complex adaptive systems and, in the process, reducing the latter to the former. Within the SFI community, challenging capitalism is deemed futile, as illustrated in works like *Bionomics: The Inevitability of Capitalism* by consultant Michael Rothschild, who was one of the members of the constellation of businessmen funding the SFI (Rothschild, 1990). Rothschild argues that capitalism is an inherent part of nature and therefore unstoppable. Now, even setting aside the ideological debate about these issues, the naturalization of capitalism presents an epistemic problem as it falsely

assumes that greed, competition, and inequalities are inevitable aspects of human nature.

This naturalization tendency extends beyond complexity sciences and infiltrates various positivistic streams of human and social sciences, including neoclassical economics (Swanson, 2008), behavioral economics (Servet & Tinel, 2020), neurosciences (Hartmann, 2011), and evolutionary psychology (Noonan, 2019). These scholarly works often exhibit a tendency to de-historicize human trajectories, emphasizing ethological, morphological, or genetic arguments while overlooking the cultural and conflictual facets of social life. Despite the wealth of evidence from other social sciences that documents diverse social orders across cultures, geographical regions, and historical periods (Cook, 2020; Fisher, 2022; Graeber & Wengrow, 2021), the naturalization and legitimation of capitalism persist in the academic field. Fortunately, notwithstanding the prevalence of this discourse in the popular literature (Fukuyama, 2006; Harari, 2016), the academic sphere offers, too, several counterexamples wherein researchers consider evidence from social science about social facts and propose a denaturalizing and repoliticizing approach to the question of social order. Computational economics, within the same interdisciplinary field as urban scientists, offers heterodox perspectives. Some economists indeed seek to integrate complexity sciences with Keynesian or even Marxist traditions (Cogliano & Jiang, 2016; Colander, 2000; Dosi & Roventini, 2019).

A notable figure in this domain, Wolfram Elsner, challenges prevailing neoclassical and neoliberal economic paradigms in his article “Complexity Economics as Heterodoxy: Theory and Policy” (Elsner, 2017). In his account, mainstream policy approaches have focused on promoting deregulation and privatization, assuming that markets would naturally lead to optimal outcomes. Elsner rejects the notion of a unique and optimal equilibrium benchmark, prevalent in “perfect market” economics. Instead, he advocates for a complexity economics perspective, criticizing Hayekian thinking and proposing interventions to adjust market disasters and prevent harm. According to Elsner’s analysis, in the neoclassical and neoliberal worldview the optimal equilibrium benchmark is legitimized through simplified economic models featuring “perfect

representative agents” and deterministic solutions. However, these simplistic models have proven inadequate in capturing the complexities of real-world economic systems, as demonstrated by the 2008 financial crisis. On this matter, Elsner argues that theories influenced by Hayekian thinking incorrectly assume that self-organization eliminates the need for proactive policy interventions, since markets are believed to generate a “natural” and “spontaneous order.” Interestingly, Elsner asserts that the framework of complex adaptive systems indicates the very opposite and, as a consequence, he arrives at a very different prescription about markets. He states that spontaneous order is not always optimal and that it is sensible to politically intervene in order to adjust market disasters and prevent harm. In his interpretation of the SFI’s perspective, socio-economic complex adaptive systems exhibit dynamics characterized by abrupt transitions between temporary order and volatile disorder. Elsner argues that complexity economics, primarily encompassing agent-based modeling and network theory, suggests that while self-organization mechanisms may occasionally lead to a unique and stable state, they more commonly result in multiple equilibria, most of which are unstable and transient. In decentralized and deregulated market economies, the emergence of problem-solving mechanisms through self-organization may be time-consuming and fragile, because recentralization of economic power through oligopolies and monopolies is likely to manifest and to produce harmful disequilibria. Elsner argues that well-designed complex adaptive policies, focusing on institutional organization, can improve incentive structures and other critical factors that influence agents’ behaviors. According to him, such policies can enhance the properties and performance of economic systems by promoting collective problem-solving capacities, stabilizing system dynamics, and fostering “superior attractors” – a term borrowed from chaos theory to refer to state policies aiming at a given social good. In the works of Elsner and other heterodox complexity economists, the role of the government is indeed to control, guide, and stabilize the economic system while leveraging the knowledge and adaptations of private agents. In this framework, policies should aim to regulate complex systems to avoid “inferior self-organization mechanisms” and consequently mitigate systemic failure.

Having served in roles akin to those of urban scientists, albeit within the framework of social-democratic governance in the State of Bremen, rather than in ultra-liberal settings like Singapore, Elsner articulates a distinct normative perspective. Importantly, his articulation is marked by a conscious and transparent approach, providing a foundation for critique – a latitude often constrained by the naturalizing discourse prevalent among urban scientists. Specifically, Elsner advocates for policy frameworks that promote market democratization, cooperation, and equality among economic actors. These frameworks, in his view, should be well-informed, analytical, and forward-looking. When defending an epistemic and reflexive approach to the economy, he cautions against technocratic approaches, advocating instead for policy designs that are both scientifically grounded and democratically constituted. Notably, he underscores the importance of adopting a Deweyan approach, one that embraces participative democracy, experimentation, and continuous adaptation. According to him, evaluating complex system dynamics and their outcomes requires a “multifaceted socio-political evaluation,” reminiscent of past pragmatist and Keynesian conceptions of policy (Elsner, 2017, p. 969). Through these statements, Elsner exhibit reflexivity and transparency. In a more precise sense, he challenges the naturalization of market fundamentalism – a tendency observed in the discourse of governments and neoclassical scholars – and openly reintroduces politics into the domain of computational economics. This stands in sharp contrast to the prevailing inclination among urban scientists, complexity economists, and other SFI fellows who often downplay policy.

All in all, Elsner’s example serves as a reminder that one of the key aims of social science is to deconstruct what societies black-boxes and to put it back into collective discussion. By challenging the concept of “nature” and demonstrating how behavior is influenced by social, cultural, economic, and historical factors, social sciences generally contribute, through their theoretical and empirical endeavors, to create opportunities for critical reflection and to question established norms. As emphasized by Durkheim in his renowned work on the rules of sociological methodology (Durkheim, 2014), social sciences should indeed play a crucial role in dismantling preconceived

notions about human behavior while accentuating its political underpinnings. Regarding computational social sciences, new digital methods should complement the traditional qualitative and quantitative tools of the social sciences (Marres, 2017), adhering to the enduring principles that have guided this field – reflexivity, historicization, denaturalization, repoliticization, etc. This may better ensure a comprehensive and nuanced understanding of the multifaceted dimensions of human society.

Conclusion

This paper contributes to the theoretical literature about interdisciplinarity through the introduction of two analytical conceptualizations and the conveyance of two normative messages. The first conceptualization expands upon Thomas Gieryn’s framework of three types of boundary work by introducing a fourth category dubbed as “merging.” The second conceptualization articulates the dynamics of expansionistic and merging boundary works through three sets of terms, enhancing our ability to discern the former and implement the latter more effectively.

As for the messages, the first one aligns with critiques of positivistic approaches to knowledge. The article demonstrates that expansionistic boundary work adversely impacts the relevance of knowledge by generating simplistic, trivial, and reductionist theories and results. The second message draws a parallel with Durkheim’s call to move beyond simplistic explanations rooted in psychological or biological aspects to understand social behavior. The paper emphasizes indeed the imperative to reject interpretations of the social exclusively through a physical, mathematical, or computational lens (Jensen, 2021). Building on the insights of Edelman et al. (2020) and Marres (2017), the article underscores the importance of integrating digital methods into social theory and advocates for the use of “qualitative-quantitative” tools (Venturini et al., 2014), commonly referred to as “mixed methods.” Recognizing the unique strengths and limitations of both approaches, the paper argues that their combined use can reveal heuristically complementary and stronger insights. Contrary to some social scientists’ claims, the issue lies not in the utilization of digital and

quantitative methods per se, but rather in the social, epistemological, and methodological approach with which they are employed.

At a broader level, the paper suggests that interdisciplinary collaboration can yield a more comprehensive and robust body of knowledge when individuals or collectives bridge diverse disciplinary backgrounds in a reciprocal and transformative manner. The merging boundary work emphasizes reflexivity and balanced power dynamics, valuing perspectives from all involved disciplines. Namely, it promotes open communication, seeks shared decision-making, and – equally important – advocates for a fair distribution of resources among stakeholders at the institutional level.

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