Hypertypes: From Social Bridges to an Urbanism of Aspirations, Affordances and Capabilities

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Using multilayered individual massive data and geo-localization tracking, Computational Social Science and Social Physics attest the importance of face-to-face and place-to-place interactions in shaping human agency. The research suggests that collective and individual behaviors can be described by the "social bridges" that bind local communities in daily activities. By looking at various metropolitan regions across the world, findings point to the resilience of social bridges in predicting economic, political and health-related characteristics of local populations. Communities that share similar practices of metropolitan spaces also express similarities in those behaviors. Such results are akin to theories of urbanism that promote the importance of spatial configurations in describing markets, power and well-being.

With this paper, I wish to look at the empirical findings of Computational Social Sciences and Social Physics through the lens of those theories, and propose a general understanding of human agency based on aspirations, affordances and capabilities. Instead of competing with previous approaches, the view that individuals act in accordance to their environment as an extension of their desires and aptitudes provides a long-waited hinge to bind Social Physics and previous theoretical models. In a second step, I discuss how such model can afford tools to architects, planners and policy-makers to increase collaboration and cooperation between local communities and decrease the economic and political polarization of contemporary metropolitan spaces.

1 Computational Social Science

Computational social science is a field of research practices seeking to understand human behaviors using digital traces. Two main "revolutions" have led to the inception of the field over the last twenty years[1]. The first revolution consists in the creation of a global digital ecosystem in the 1980s and 1990s, when States, corporations and institutions began to digitalize documents in order to facilitate the exchange and the archiving of knowledge. Soon, the production of digital data would take over analogous work and feed an increasingly thick flow of information. The ongoing the production, alteration and exchange of digital information motivated large corporations as well as governments to exploit the digital traces left by individuals for financial and security purposes. As soon as they could access this data, researchers who had been behind most of the infrastructure that allowed the growth of the online digital ecosystem began to raise questions about the risks and potential of these digital lives. The second revolution was the discovery of two network models that could describe certain social phenomena, such as the Internet and group interactions.

[1] Nicolas Baya-Laffitte and Benbouzid Bilel. "Présentation. Imaginer la sociologie numérique". fr. In: *Sociologie et sociétés* 49.2 (2018), pp. 5–32.

The "Small World Model"[2] and the "Free-Scaling Model"[3], both developed in the late 1990s, became keys to describe human organization and interaction in terms of basic mathematical principles.

Although the notion of a "computational social science" had already been put forwards in the 1990s by geographers[4], it was not until much later that the field gained enough momentum to claim its own existence. In 2009, a group of US American researchers published an article in Science arguing that the study of digital traces would "transform our understanding of our lives, organizations, and societies"[5]. The authors, who already specialize in applying network theory to human behavior, point at the risk that Tech Giants and national security services already carry such research behind closed walls. With scientific backgrounds in business, management, sociology, history, human behavior, politics, network and computer research, they argue that a new epistemological and ontological paradigm may emerge from the acute tracking of every single behavior and the unparalleled attempt to map a holistic network of society.

2 The Urban Shift

In the last decade, Computational Social Science has shifted its focus from the digital space of social media to the analog space of cities and metropolitan regions. The increase digitalization of urban practices, fueled by ubiquitous connectivity and an abundance of connected services has fostered such transition. Yet researchers have transposed the tools and methods, as well as the approaches and habits developed for analyzing social behaviors online, to the urban "digital ecosystem." Similarly to online platforms, cities ensure a constant and thick flow of information that outperforms other types of social and material environments. The density and diversity of urban societies might well resemble the one of social media, with the added complexity of hinging multiple dimensions and functions simultaneously. While limited number of functionalities constrain online behaviors, urban space offer much greater freedom and opportunities. A constant flow of innovation feed by dense and diverse individuals animate metropolitan regions. Yet, the skills in gathering, managing and analyzing Internet data offer a head start to tech giants and Computational Social Scientists. It is not surprising to find Tech Giants have been increasingly invested the city by using their platform to directly produce data on urban behaviors. But contrary to online platforms, the city is produced by a multitude of actors: private individuals, corporations, businesses, institutions, organizations, groups and communities whose diverse aspirations and constant wayfaring shape the dynamics of metropolitan regions. The actions and interaction of actors that produce the city has been an important focus of research in social and human science. But the lack of interest from tech giants and Computational Social Scientists for the existing literature on urban social dynamics raises concerns for critical social and human science.

The genealogy of Computational Social Science has led its practitioners to focus on the interweaving of humans and objects, thus leaving the immaterial components of cities unattended. On the contrary, Computational Social Science maintains an ambiguous relationship with social science and its theoretical legacy. Similar to what occurs in design practices, most of the field does not propose a clear theoretical agenda[6]. Ironically, researchers who demonstrate that innovative arises from maintaining diverse sets of relationships refers chiefly to the work of its peers. Few references to classical work in the social science often serve as an anchor to ground research questions in a social narrative. For example, many publications in Computational Social Science mention Granovetter's "strength of weak ties" to support the idea that the diversity and density of social relationships are affordances that fuel economic growth and innovation. On the one hand, authors rarely discuss these references past the introduction section, which seldom serve to nuance the findings. Likewise, most papers remain silent on how the impressive computational "tour de force" put forward in the studies can contribute to current debates in the social science. Thus, many findings appear anecdotal from the perspective of sociology, geography and economics, which have, in their own way, already provided theoretical explanations and empirical validations to the phenomena that Computational

[2] Duncan J. Watts and Steven H. Strogatz. "Collective Dynamics of 'Small-World' Networks". en. In: *Nature* 393.6684 (June 1998), pp. 440–442. ISSN: 1476-4687. [3] Albert-László Barabási and Réka Albert. "Emergence of Scaling in Random Networks". en. In: *Science* 286.5439 (Oct. 1999), pp. 509–512. ISSN: 0036-8075, 1095-9203. [4] W. R. Tobler. *Three Presentations of Geographical Analysis and Modeling*. en. Technical Report 93-1. Santa Barbara, CA: University of California Santa Barbara, Feb. 1993, p. 24. [5] David Lazer et al. "Computational Social Science". en. In: *Science* 323.5915 (Feb. 2009), pp. 721–723. ISSN: 0036-8075, 1095-9203, p. 721. [6] Baya-Laffitte and Bilel, see n. 1, p. 10.

Social Scientist thrive on.

3 Searching for Innovation, From Honest Signal to Social Bridges

Sandy Pentland, who is a leading figure of Computational Social Science, presents an alternative to this practice by crafting a social theory of innovation. He argues that the social world is governed by an intrinsic set of rules based on face-to-face interactions and the transmission of what he calls “honest signals”: an unconscious level of communication between individuals that drives group and collective dynamics and decision-making processes. In an attempt to enlarge the scale of those interactions, he develops the idea of a “social physics,” based on the approach developed in the early 1800s by French sociology pioneer August Comte who sought to model urban behaviors following a Newtonian stance. Pentland based his model on a series of studies he has conducted in the foregoing ten years, and provides one of the few existing attempts to build a theoretical model for Computational Social Science. The city and society play a central part of his argument. Pentland compares the use of data as a way to “sense” the nervous systems of cities and reason that Social Physics and Big Data have the potential to “revolutionize our understanding of cities and development.” Using Social Physics, Pentland develops an argument for ways to improve health, safety and efficiency in cities. For him, we would be able to design better cities by focusing on how ideas circulate from one person to another, from one place to another, and harvesting the potential of these innovation vectors. In the context of an ongoing shift towards a “Data-Driven Society,” Social Physics may even help us to design a human-centric society by opening up the possibility to operationalize “reality mining”: the ubiquitous and constant production of data about ongoing events. While Social Physics proposes a framework to understand cities as social dynamics, it lacks of explicatory concepts common to the social science. In order to operationalize the research in Computational Social Science to address urban and societal issues, I propose to create a common ground to both traditions. Such an approach could therefore also contribute to secure the active engagement of Tech Giants in urban planning and governance policy making. To this end, researchers of the MIT have put forward a first concept that explains how Social Physics functions: the notion of “Social Bridges.”

“Bridges” are a central concept in the network science literature, especially for the new types of network models developed in 1990s. In social networks, a bridge refers to a set of connections between two clusters of nodes. By connecting what would otherwise be two separate components, bridges constitute a key element for the network’s resilience and integrity. Empirical research on network-like processes in human organizations show that bridges—often consisting of people acting as a liaison between two groups—hold a central position within the organization, and concentrate most of the information. In the context of Computational Social Science, I find the first mention of “social bridge” in the doctoral dissertation of Alfredo Gonzales-Guzman[7]. He refers to the research showing that among millions of mobile phone users, certain individuals “behave like social bridges, allowing information to flow across communities in the social network” (p. 35). While removing intra-community ties has little effect on the network, removing the few inter-community ties destroys the whole system. In the context of Twitter activities, Morales-Guzman describes those individuals as “active consumers” (in opposition to Information Producers and Passive Consumers). He notes “although individuals may have psychological and contextual differences, the dynamic patterns are due to simple and universal interaction mechanisms” (p. 167). This position of Morals-Guzman reflects a generalized stance in Computational Social Science. In his own work, Pentland makes many implicit references to the notion of Social Bridge. For example, in order to illustrate how idea flow relates to decision-making processes, Pentland[8] refers to a 1985 study by the physicist Kelley[9] that shows that Bell Labs employees with the most diverse and frequent social interactions make the most decisive innovations. Only recent, however, did Pentland and his colleagues began to conceptualize the notion of Social Bridge, and point at how it could be operationalized in planning cities.

[7] Alfredo José Morales-Guzman. “Analyzing and Modeling the Emergent Dynamics during the Information Diffusion Process on Internet Social Network”. en. Doctoral Dissertation. Madrid: Universidad politécnica de Madrid, 2014. [8] Alex ”Sandy” Pentland. “Beyond the Echo Chamber”. In: *Harvard Business Review* November 2013 (Nov. 2013). ISSN: 0017-8012. [9] Robert Kelley and Janet Caplan. “How Bell Labs Creates Star Performers”. In: *Harvard Business Review* July–August 1993 (July 1993). ISSN: 0017-8012.

Despite being the focus of little research, the notion of Social Bridge shows promising explanatory power of collective human behaviors. Moreover, it provides an entry point for planners and policy makers to maneuver economic redevelopment and channel a just redistribution of capital flows. Dong and colleagues[10] offer the first conceptualization of the notion in studying the role of Social Bridge in purchasing behavior. Using credit card records, the researchers look at millions of banking transactions in Istanbul and they find that the share of people from different areas of the city that work nearby each other better explain the similarity in purchase behavior than traditionally considered factors such as income and sociodemographic variables. Using a similar approach, they also show how spatial behavior explain the political orientation of certain areas of metropolitan regions[11]. For the researchers, this phenomenon shows the "effect of co-location and face-to-face interactions on individuals' behavior." The study also refers to previous work in Computational Social Science on the effect geographic proximity and co-visits on online friendships attitudes[12], and face-to-face conversations and offline relationships[13]. Despite the topic and the argument put forward, the authors refrain from referring to past or recent social science studies with similar concern. One notable exception is the pivotal work of psychologist Albert Bandura on social learning, which "has been studied in the context of purchase behavior."

4 The Underlying Rational

In his Social Learning Theory (SLT), Bandura[14] argues that a large part of the individual's behavior results from their exposure to the people that surround them. This "environmental" take on human cognition proposes a new set of mechanisms to explain a person's agency. According to SLT, humans learn mostly by imitating the behaviors they are exposed to. However, in this process, people mediate these behaviors through a series of conditions: attention, retention, reproduction and motivation. More than a simple model, SLT anchors Computational Social Science, and its notion of Social Bridge into a new paradigm of human agency where habits and beliefs circulate among networks of individuals, like energy fluxes. In the 1980s and 1990s, scientists have tried to build mathematical to model human learning processes. Today, much AI use "Social Learning Algorithms" to solve optimization problems. Still widely referred to in computer science, especially for research on Swarm Computing, SLT is absent from the literature in social science, and especially in fields preoccupied with space, cities and planning. For example, the notion appears nowhere in Progress in Human Geography, and only appears in three articles of Environment and Planning, and in Urban Studies.

The way that Social Science and Computational Social Science conceive human agency plays a central role in the difficulty to bind their views towards an operational practice. As Boullier notes[15], this discrepancy is closely related the nature of the data they treat, and its ontology. Most research in Social Science relies on data that is either produced for a general purpose, or to address specific questions. National census, surveys and interviews fall into these categories. Researchers take an active role in producing data, even if its purpose is not exactly defined. Social Science still struggles with how to define human agency. Are actions and attitudes resulting from external factors, or are human intrinsically free agents that are able to self-realize? In Computational Social Science, data is incidental to the digitalization of information. Humans are neither the products of their contexts or free agents, but vehicles of ideas, beliefs and attitudes, agents in a swarm of collective intelligence.

By optimizing the diffusion of information in the city, Social Bridges increase the innovative function of urban spaces. While telecommunication play a growing part in maximizing this process, face-to-face interaction remains a driving factor to the collective urban agency. By connecting distant parts of the city, individuals help propagate ideas and diffuse information, which leads seemingly distant populations to adopt similar behaviors. Computational Social Science tries to model this dynamic phenomenon in order to optimize the way cities function. From this perspective, a smart city is a city where digital traces serve to

[10] Xiaowen Dong et al. "Social Bridges in Urban Purchase Behavior". In: *ACM Trans. Intell. Syst. Technol.* 9.3 (Dec. 2017), 33:1–33:29. ISSN: 2157-6904. [11] Xiaowen Dong et al. "Purchase Patterns, Socioeconomic Status, and Political Inclination". en. In: *The World Bank Economic Review* (2016), p. 5. [12] **Sun (2011) and Cho et al. (2011)**. [13] **(Wyatt et al. 2011; Chin et al. 2012)**. [14] Bandura Albert. *Social Learning Theory.* Englewood Cliffs, N.J.: Prentice-Hall, 1977. [15].

facilitate the circulation of information between humans and non-human actors in order to build a collective intelligence. As the grip of Tech Giants on urban planning is growing, a bridge between Social Science and Computational Social Science may offer a human-centric alternative to for-profit city design. Yet, to achieve such connection, we need to reconsider need ways to make both fields of research compatible with planning and policy-making practices.

5 Operationalizing Computational Social Science

In an article published in 2016, Pentland[16] argues that an increasing segregation of interaction in the city leads to political polarization. In order to provide a solution to the rise of ideological conflict, city design must facilitate if not encourage the face-to-face interaction of distant communities. In other words, planners and policy must to find ways to increase the number of social bridges between politically, socially and economically opposed groups of people. Taking a similar stance, Hidalgo and colleagues[17] argue that an operational application of Social Bridges has the potential to boost the economic growth of urban areas, thus allowing for a fairer distribution of wealth and opportunities. Transportation infrastructure should be planned in order to facilitate knowledge flows towards poorer industries and regions. Evidently, there is an alarming resonance in suggesting applying general urban planning strategies from a universalist theory with only little empirical validation. Social Science has spent the last thirty years warning us against such risky approach and the potentially disastrous consequences of operationalizing positivistic knowledge.

The operational application of scientific knowledge into operable urban planning strategies and governance policies is a central goal for the sustainable development of metropolitan regions. Social and human Science have had long experience in operationalizing research in order to empower local communities and decrease social and economic inequalities. A driving factor behind the practice of urban planning was systematic surveying of the health and economic conditions of city inhabitants. The history of urban planning is split between two complementary approaches: empirically driven policies by which urban planners and policy makers carefully implement new infrastructure and mechanisms based on research; and a model based approach, guided by an intuition over bold principles. A balance between the two approaches requires a situated understanding of urban social dynamics. To deal with cities is to deal with the interest of millions of people, their habits, their memories, and their aspirations. Therefore, the "solution" put in place must make sense for the people who are affected by this operational application. This should be taken into account, not only when the time comes to create a planning strategy, but also when we start producing knowledge that will eventually feed the work of policy makers, planners, as well as all the other public and private actors engaged in city making.

6 Human Agency & the Generational Problem

What planning and policy-making experience today is an ontological problem of spatial agency. Space is not a neutral set of distance between things, it is a distance that makes a difference for someone or something. Keeping with this definition, cities are the densest and most diverse concentration of agencies, and therefore the most complex system of space. Architecture and urban planning have traditionally relied on an "ektological approach to space," by fixing functions, usage, purpose, and meaning. Social Science, however, highlight space is an ontological construct: its intrinsic characteristics are ever changing as there are viewpoints on it. The difficulty to work with an ontological understanding of cities arises from the dynamic nature of ontologies. This is why, sometimes, we need "ektologies," fixed and shared definitions of urban spaces in order to define operational actions. A risk arises, however, when these ektologies get dominant and begin creating fixed categories of people. LEM Taylor[18] points out the risk associated with large Tech Corporations leveraging Big Data to plan cities reside in the way they use ektologies to describe

[16] Alex "Sandy" Pentland. "To Rescue Democracy, Go Outside". en. In: *Nautilus* (Oct. 2016). [17] César A. Hidalgo et al. "The Principle of Relatedness". en. In: *Unifying Themes in Complex Systems IX*. ed. by Alfredo J. Morales et al. Springer Proceedings in Complexity. Springer International Publishing, 2018, pp. 451–457. ISBN: 978-3-319-96661-8, pp. 454-5. [18] Linnet Taylor. "What Is Data Justice? The Case for Connecting Digital Rights and Freedoms Globally". en. In: *Big Data & Society* 4.2 (Dec. 2017). ISSN: 2053-9517.

their users. I argue we must develop an ontological approach to data-driven urban planning harvesting the potential offered to us by Computational Social Science. In other words, the complex trade off of the agency of inhabitants and communities should balance out the agency of corporations, but also researchers.

The importance of considering the ontological dimension cities in the multiplicity of agencies that constitute urban space is the core argument of Henry Lefebvre's "Right to the City." In his manifesto for an urban society, the French rural sociologist and philosopher defends the idea that the city made of multiple simultaneous engagements. For Lefebvre, the city is a function of reality, not a "complex system" that can be divided into intelligible layers, with specific boundaries and a center. The cities must be produced by an ontological analysis centered on the relationship between various points of view. In doing so, Lefebvre wishes to renew our understanding of cities by going against spatial determinism and show that space is a material expression of social determinants. The true "Right to the City" comes from the inclusion of all existing ontologies of the city, from the perspective of all actors for whom the city makes a difference. The city is not an object, but a social reality. Therefore, a smart city should not be a set of smart objects, but characterizing our smartness of inclusion. There is therefore a need to account for the diversity of ontologies of the city, which means to account for the diversity of agencies that form the city.

Planners and policy-makers must adopt a careful stance towards the tools and knowledge produced by Computational Social Science, but also learn to profit from the potential their approach gives to understand the diversity of human agency. Planners and policy makers are experts in exploiting the agency of city dwellers, communities, businesses, etc. in order to achieve what they define as collective aspirations. They harness our desires, our dreams and our needs and canalize those into "productive outcomes": economic growth, redistribution, control of transit flows, etc. In order to optimize this process, we would need to know exactly what people do at every single moment. This is what CSS offers, the possibility to "mine reality" and in permanence (alwasy-on) so to use our willpower to fuel the city. On the good side, this could be used to our own benefits and attain social objectives of sustainability, social justice and empower people. On the bad side, this could also be used to mostly fuel corporate interests or the aspiration of a certain elite, here or elsewhere. This is already what is happening, and this is why we must remain vigilant on how our data is being used and for whom. This is not necessarily done consciously but social inequalities between data producers can arise from structural decisions, such as strict ektologies.

While the consequence of ontological mismatch is frequent in science, its consequences can be disastrous when this knowledge is being operationalized. Through the work of Tech Giants, Computational Social Science has already begun to plan neighborhood of major metropolitan regions such as Toronto. Social Science has had a long relationship with urban planning and policy making. Such relationship should greatly benefit the data-driven planning projects by offering a critical understanding of the role of context and agency. While current approach in data-driven urban planning has a difficulty to recognize the multiplicity of identities and aspirations of metropolitan dwellers, Computational Social Science offers the opportunity to understand and work with this level of complexity. This would allow us to avoid going back to a fragmentation of urban knowledge, such as it occurred during the modernist movement. While planners and policy makers should remain especially attentive to the research done in Computational Social Science, both to avoid an urban and social setback, but also to profit from its capacity to address the multiplicity of human agencies. A current trend to isolate Computational Social Science from the critical knowledge of Social Science pauses the risk to concentrate operational power in the hands of private interests such as Tech Giants, but also banks, insurances, and other major providers of Big Data. We need to better frame human agency in a transdisciplinary was to secure the right of all actors to take part in the operational application of knowledge on cities.

7 TRIAD: A Transdisciplinary Model of Human Agency

In the last section of the paper, I present a transdisciplinary model of agency that establishes a common ground to the research practices of Social Science and Computational Social Science, and the operationalization of their knowledge in urban planning and governance policy making. The model proposes to put into relation three notions that already appear in Social Science, Comptutational Social Socience, as well as in certain operational practices of urban planning and policy making: Aspirations, Affordances and Capabilities. Generic enough to encompass the concerns across these disciplines, this "Transdisciplinary Model of Agency," it is also specific enough to be used as a tool in both research and practice. The model offers a united framework to locate and evaluate the agency of the actors that make the city. It also provides keys to understand certain phenomena like the social inequalities and political polarization.

The first notion of the TRIAD model are Aspiration. The word itself both means to dream and to breath in. In the city, there are as many dreams and there is breath, and this is what makes the city live. In the model that I propose, Aspirations are what people want for themselves, for others as well as for society in general. Getting a raise, meeting new friends, making somebody happy or attaining equal rights are examples of aspirations. They correspond to the desired state of personnel, collective or societal situation. They may be centered on oneself or on others. Aspirations describe ideal social or material situations that motivate us to act. Aspirations may be complementary, contradictory, combined, alternatives or neutral to one another. They force us to look for opportunities and ressources, but also to develop the necessary skills to actualize them.

The second notion of Affordances consist of the people, objects and situations in our environment that we use to achieve our Aspirations. They can be finite such as ressources, or infinite such as common goods. The community by which we define ourselves, the stranger who points us the right way, our teachers who taught us to read, or that acquaintance who tell us about an open position, are examples of social affordances. The bench on which we sit to rest, the bridge we take to pass a river, the 4G waves that connect us to the internet are example of physical Affordances. They correspond to social or material spatial configurations that allow the actor to actualize their aspirations. They describe actual or virtual situations used to act. Affordances may be simple, multiple, positive or negative. Affordances make sense only in relation to the Aspiration that define their purpose. But the possibility to actualize our aspirations also depends on our capability to perceive the right affordances, and to use them accordingly.

The third notion in my transdisciplinary model of agency are Capabilities. They consist in the skills that individuals develop in order actualize their Aspirations by making use of the Affordances. The capability to read a sign or to navigate a neighborhood, to remember where things areas are situated, to parallel park, to develop one's professional network, or to address a larger public allow us to attain small and large aspirations daily. The capability. In other words, Capabilities correspond to embodied or extended competences that the actor develops. They describe personal or collective aptitudes that enable us to act on affordances in order to actualize aspirations. To hone certain capabilities are aspirations of their own, and the capabilities of other can become affordances if we solicit them.