Questioning the enduring but fragile materiality of digital traces: the case of social media analytics

François Lambotte,
UCL Social Media Lab
Université catholique de Louvain,
francois.lambotte@uclouvain.be
With the support of the European Regional Development Fund (ERDF)

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For several decades, the literature in computer science (Bannon & Kuutti 1996) deals with the capture, centralization and exploitation of our digitally-mediated interactions and the resulting productions. In a positivist and almost utopian vision, we see computer science as a solution to the incompleteness and approximation of human memory. The indexing tools, artificial intelligence will facilitate the recovery of information and will create an organizational memory whose properties, such as completeness, will be much higher than those of men (Huber, 1990). Even if one understands the value of creating a shared memory of all our communications (conversations, texts, etc.), this vision is simply not realistic since the cooperative activity in the organization is dispersed (Vásquez & Cooren, 2013). Therefore a system like this one would necessarily be partial and incomplete. Thirty years later, one might think that the debate is over. It is far from being the case. Indeed, this illusion of "completeness" is growing in the discourses of IT solution providers whose arguments are based on (1) the increased use of digital tools in an organizational context, the increased capabilities of (2) capture, storage and (3) processing of our digital traces:

1. The increasing use of digital devices in business interactions – emails, enterprise social media such as Yammer, Facebook Business, Elium, or collaborative tools like GoogleDrive, SharePoint, Slack – creates a mass of traces of our interactions including their contents and metadata (the *logs*: who, what, how, when). Although these digital traces constitute one mode of existence, among others, of our interactions in organizations, these can nowadays be the subject of very advanced analyzes.
2. These analyses rely on constantly evolving capture and storage capabilities. With the acceleration of digital innovations, we are delegating to machines – tertiary retention tools according to Stiegler ("Rétention | Ars Industrialis", s. d.) – the storage and retention of all our digital interactions and productions. We store, we sort but we do not throw anything (Van House & Churchill, 2008).
3. The exploitation of data, given the quantity collected, is no longer a human task (Bowker, 2014). Once collected and stored, the traces of our interactions are subjects to calculations made available in different formats such as reports or dashboards composed of numbers, visuals or graphs.

This article focuses on social media analytical tools which for the end-user usually take the form of a dashboard gathering ready-made data visualizations. In our specific case, the tool

provides a visualization of the organizational network based on the traces of digitally mediated interactions among active users of the platform. The tool is interactive and provides a number of optional settings to the user. The tool bar on top of the figure 1 shows that the user can select

- to visualize the whole network or part of it,
- the nature link between nodes being represented,
- the timeframe of historical data taken into account,
- the type of nodes (binomials or not).

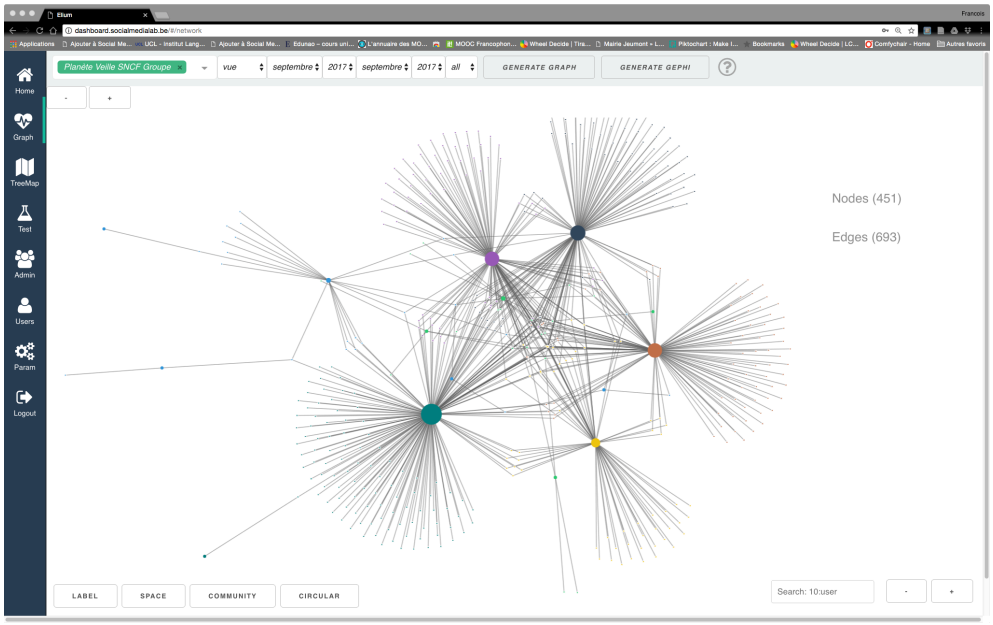


Figure 1: Analytical tool prototype

A social media analytical tool can be considered as thinking infrastructure "enacting different rationalities" that hypothetically influence community managers' or members' sensemaking of digitally-mediated interactions. Our aim is to enter the factory of the social media analytical tool from the creation of digital traces to the visual graph representing a social network based on these traces. In so doing, we question the process of translation (Akrich, Callon, & Latour, 2006) that "emphasizes the manner in which entities' interests, goals, or desires are represented, simplified, and transformed in the production and mobilization of artifacts" (Shiga, 2007, p.40).

If we adopt a communication perspective, the visualization produced constitutes a text, in a very broad understanding, made of signs which are understandable by human beings in their organizational context. More, the production of this text can be defined as an *editorial enunciation* which in Souchier's terms :

"designates all that contributes to the material production of the forms that give the text its consistency, its 'text image'. It is a determined social process, most of which is largely invisible to the public, but which can nonetheless be understood through the mark imprinted by the professional practices that constitute the elaboration, constitution or circulation of texts. This is why the notion of enunciation does not refer here to a linguistic metaphor; it suggests, instead, that below or above the discursive enunciation of a given text (the work of a famous author, the text of a regulation or the mosaic of a newspaper, for example) is another enunciation, of another order, even if it is closely related to it. This other level of enunciation defines the very forms that make the text possible, which allow it to have a visibility: what leads it to be hierarchical or not, to conjugate the speeches of such and such a way ... More fundamentally, editorial enunciation is that by which the text can exist materially, socially, culturally ... in the eyes of the reader" (Jeanneret & Souchier, 2005, p.6).

With computerization, the editorial enunciation has changed. It implies "that the process can no longer be apprehended solely through the traces of production and socialization practices of the text, but rather through the very conditions of its literal elaboration" (Jeanneret & Souchier, 2005, p.9). Considering the fabric as an editorial process, we emphasize the roles of different beings, humans and non-humans, in the production of the visualization of the organizational network.

This contribution questions thinking infrastructure investigating the way elements composing the factory of the analytical tool *matter* and are key in making digital traces of past interactions *to endure* which in Stengers' words, is understood as, "for better or worse, an achievement of a feature that goes on mattering" (Stengers, 2005, p.48). Yet, before entering the fabric, we need to further explain what we understand by mattering and the role of communication in this process.

A communication perspective on mattering

In order to understand the notion of matter, it is necessary to go back to the debate on the notion of materiality. This discussion emerged at the end of the 2000s under the impetus of Orlikowski (2007) with the aim of considering the technology and especially its materiality which was fundamentally absent from the analyzes carried out notably on the basis of *the practice-lens* (Orlikowski, 2000). Then arose a wider debate on the articulation between the social and the material. As Paul Leonardi (2013) argues, there are two theoretical approaches to socio-materiality. The first is the one based on agential realism and the second on critical

realism. Both differ in their conceptualization of the interpenetration between social and material. For Barad (2007) – reference author of the agential perspective – there is no separate existence of material outside the social. On the other hand, as advocated by Leonardi, critical realism considers the social and the material as separate entities that are related to one another through human activity and can, at a given moment, become inseparable over time. It is a way for Leonardi - who does not deny that technologies are the result of a social process - to affirm that this technology, this material, has an existence, fixed, with crystallized properties that precede their re-appropriation in other circumstances. What technology is not change over time and space but what it does can change each time it is remobilized into an interaction or action. If we take the simple example of the design of the hammer, one can reasonably ask whether the fact that the hammer fits or not and therefore have properties that exceed those desired by its user could have been noticed outside of this moment where the social meets the material.

In his article "*InMedia Res: communication, existence and materiality"*, François Cooren returns to this question of materiality in relation to communication rather than in opposition (2015, p.2): "Instead of fruitlessly opposing communication and material worlds, we thus need to conceive of communication as involving not only humans but also various beings that emerge in interaction. These forms of emergence are the ways by which beings gain more or less existence and materiality. As implied in any relational ontology, I am thus advocating a logic of addition and subtraction, a logic according to which various beings come to exist, more or less, depending on their capacity to literally pass or come across through other beings, including us."

Going beyond the duality set out above, the study of communication becomes "important not because our world is socially constructed – if by social construction, we mean a world that is essentially built and co-constructed by human beings – but because communication is the way by which various aspects of the world come to express themselves, more or less, in and through interaction" (Cooren, 2015, p.3).

Then Cooren (2015, p.5) defines "the materiality of something or someone – whatever it, he, or she is – always has something to do with its, his, or her state of being material (i.e., what material-*ity* means) and being material means that this being is itself made of *matter*, that is, what stands under its, his, or her being. Whether we talk about a computer, hammer, rock, lawsuit, or, as we will see, a discourse or concern, speaking about its materiality thus consists of problematizing what sustains or supports its existence or being."

Applying Cooren's definition of communication to the *editorial enunciation*, we can analyze, through each step that makes up the factory, the modalities through which *beings*

interact with each other. We can question the way beings – defined as *passers* because they make the *difference* by their actions by altering in one way or another the elements that support a particular mode of existence of these recorded interactions – sustain with more or less gradation the variable and fragile materiality of these digital traces and participate in the constitution of the analytical tool.

Through the following case study, we would like to illustrate and discuss the different modalities of interactions among beings and question their influence on the materiality of our digitally mediated interactions. The modalities in our case study are: capturing, selecting, sorting, reasoning, writing from a computational point of view and from a graphical point of view, and narrating.

The factory of a social media analytical tool

This reflection is part of an applied research project, where we work specifically on the intelligibility of social media activity for community animators and community members. In this context, we collaborate with a company that has developed an knowledge sharing platform. The company in question wishes to provide its customers with tools for analyzing the digital activity of collaborators. Figure 2 shows the whole translation process that we discuss: T1 to T4 illustrate the four translations that the online interactions undergo since their extraction to their visualization in the form of a social graph. Online interactions on the collaborative platform are classical. One can post content (URL, Files, Wiki, status) in a specific space (thematic forum). Once posted the content can be viewed, commented or liked. One can also mention other members using the platform. All those actions create online interactions among members. All actions are registered in a logbook. *Logs*, namely a timestamped recording of our interactions on the platform include: name or nickname of the person carrying out the action, the timestamp of the action, the type of actions (post, comment, like, share, mention someone). The logs can be extracted (T1) using an API “application programming interface”. The extracted logs are then formatted in a repository (T2) and made available for exploitation by algorithms in charge of both calculation (T3) and the visualization (T4).

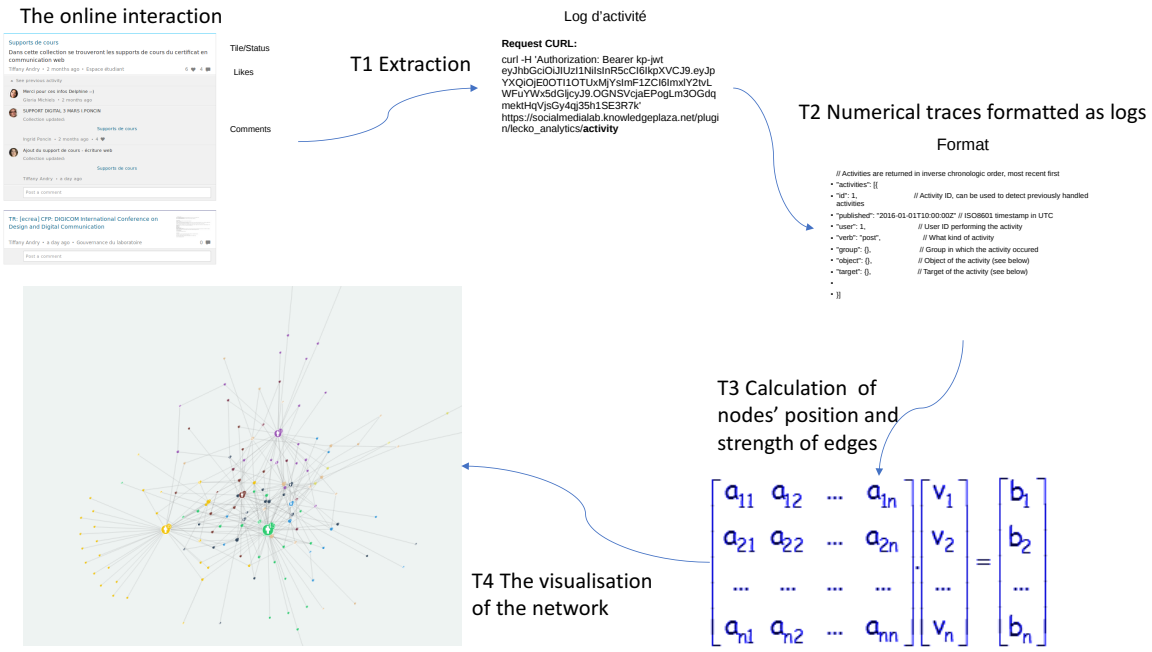


Figure 2: The translation process under study

Creating, extracting, selecting and formatting digital traces of our interactions

The first modalities of interactions that we discuss are those of creation, extraction, selection and formatting of logs considered as digital traces. As Cléo Collomb (2016, p.176; our translation) puts it well: "From the moment we interact with each other through the mediation of networked computers, our relationships are *engrammed* in digital formats that discretize them, capture them and offer them to different treatments, calculations, exploitations and standardizations." Are these traces true reflections of our interactions ? We state three criticisms.

First, traces are decontextualized. From their production, traces "are aggregated with other data, stored in distant reservoirs, scattered in a lot of sites thus largely exceeding their production context and leading their life in a certain autonomy relative to the singular presence at the origin of the enunciation ... Thus dismembered in volatile and autonomous traces, the statement is found loosed by its author whose intentionality is (at least in part) disseminated." (Collomb, 2016, pp.178-179; our translation).

Second, these traces are scattered. Indeed, with so-called media convergence (Jenkins, 2006), it is easy for users to publish or not, the same content on several different platforms. Indeed, it is common in our daily practices to use multiple platforms to support our activity. Although data storage (Van House & Churchill, 2008) becomes simpler, to structure, to organize and to combine data from diverse sources remains a major challenge for scientists

dealing with big data (Tufekci, 2014). More, their conjoint comparison and exploitation continues to be hazardous from a theoretical, legal and ethical point of view.

Third, the data infrastructures, the political, economic and technical reasons for their existence are invisible and unknown to the public (Alcalá, Star, & Bowker, 2016). Even if they are not known, these infrastructures do not, however, have any effect on our memory practices. As Geof Bowker (2005) puts it: by recalling everything and only certain facts, discoveries, observations, these data infrastructures actively and consistently engage in forgetting other data sets. Which gives them great power in our societies.

Users of the collaborative platform under study explain that project management practices use *Google Doc* during the call for tender to write collaboratively the offer, *Slack* or similar tools during the project to ensure fast and mutual adjustments and the collaborative platform for competitive intelligence or archiving activities. Moreover, the platform had a readymade API from which it was possible for us to extract data. Yet, for security reasons, these data did not include shared contents, tags or metadata related to members of the instance understudy. Analysing extracted data, we also realised that logs related to views, the most basic behaviour on such platforms, were not included. We had therefore to negotiate with the partner in order to transform the API. Once collected and stored, data can be structured using different protocols (e.g., SQL or ElasticSearch). These protocols are not without consequences as they can potentially influence the speed and accuracy of data extraction and calculation. We opted for ElasticSearch because "data is so fast-moving and voluminous, it is increasingly impractical to analyze using traditional offline, read-only relational databases" (Kononenko, Baysal, Holmes, & Godfrey, 2014, p.1). Basically, ElasticSearch decouples indexing of continuously changing data from the query of the algorithm. Hence when the query starts, documents are already pre-indexed reducing the processing time. Although, it improves the speed of queries and the comfort of end-users, this type of protocol creates a marginal error on data accuracy. Even if this error is marginal, it needs to be controlled.

Hence, those beings capture and extract only the logs of interactions occurring on the collaborative platform and leaving aside their contents and other interactions which traces were not captured. In so doing, they act, by substraction, as *passers* on the materiality of interactions which are either discretized and decontextualized or simply forgotten.

Algorithms as writers of the story of digitally-mediated conversations (translations T3 and T4)

Despite the fragility of the elements underlying the materiality of the digital traces as they are extracted (translation 1), restricted and formatted (translation 2), they constitute the raw material of new forms of exploitation: algorithms. If, according to Cardon (2015), these algorithms are devoid of intelligence, their designers are not. Like Paul Dourish (2016), we think that it is essential to look inside these algorithms. Applying Bachimont's work on computational reasioning, we consider that algorithms, as beings, develop key modalities of interactions with digital traces. These modalities are: reasoning and creating new knowledge based on calculation, writing, and finally narrating a story of organizational interactions.

First, in Bachimont's terms (Bachimont, 1996), algorithms enabling the analysis of social graphs are weak models in the sense that they are not predictive. Nevertheless, it is not because these are weak that they are useless:

"By constructing expressions that people have never written or uttered, the formal system can bring awareness of meaning formations corresponding to new knowledge in the field. The computer tool provides the means to build new knowledge previously unexpressed, even hitherto unthinkable because they call, to be formulated, calculations beyond cognitive abilities. The important point is the effectiveness of formal systems: it is only because the system calculates, automatically infers, mechanically constructs new symbolic configurations, that we find ourselves faced with formulas that we had not anticipated" (Bachimont, 1996, p. 10). Moreover, once acquired in a particular context, models can produce new knowledge on this particular context.

Second, the algorithm, as a formal system, produces new knowledge because these are written on a support. Yet, the technique of inscriptions relying on calculation differs from the one relying on graphics.

"The graphic reason rests in principle on the fact that speech has projected itself on a material support. The fact that the medium is material introduces two fundamental elements: permanence and spatiality […] Spatiality reveals relationships whose awareness is based only on the synopsis proposed by spatial representation. It substitutes the *hearing successively* to *seeing together*. But, to see it together is possible, it is necessary that there is permanence of the support: indeed, there is a view together in the sense that, with the gaze passing from the first element to the second, it is not that the first element vanishes, thus making any return to this element impossible […] The hypothesis we formulate is that computer science, in the form of automatic formal systems, provides precisely a new type of support, dynamic supports, to which a specific type of synthesis must correspond, and consequently a specific rationality, which we propose to baptize computational reason […] resting on the calculated synthesis,

insofar as the space where the computer moves is not the physical space, but that of the computation." (Bachimont, 1996 p.14-15).

The computing artefact is a formal model that produces new linkages among elements which remain, for Bachimont, virtual unless actualized by the users or by the computing artefact that re-write those linkages in order to produce new knowledge. Indeed, this translation into graphical signs makes it possible to read calculations that, if not readable, would have no impact on communication as Jeanneret explains (Bazet, Hémont, & Mayère, 2017).

In our case study, the algorithms used are ForceAtlas2 (Jacomy, Venturini, Heymann, & Bastian, 2014) and the algorithm of Louvain (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008). On the basis of massive processing of collected digital traces, these algorithms perform a series of calculations (T3). These calculations are then used to map and visualize conversations as a social graph (T4).

ForceAtlas2 is a "force directed layout which stimulates a physical system in order to spatialize a network" (Jacomy et al., 2014 p.2). Like other force-directed algorithm, ForceAtlas2 relies on certain formula to calculate attraction and repulsion forces. The attraction force depends linearly on the distance between interacting entities while the repulsion force is based on the calculation of degrees that is the number of connections that is the number of edges per node. In so doing, "the very essence is to turn structural proximities into visual proximities, facilitating the analysis of social networks" (Jacomy et al., 2014 p.2). Note that settings in the algorithm can affect the calculation but most importantly the visual configuration of the graph. For example, by default, ForceAtlas2 does not weight the edges which "can have a dramatic impact on the result" (Jacomy et al., 2014 p.4). It has also a ''Dissuade Hubs''[…]to grant authorities (nodes with a high indegree) a more central position than hubs (nodes with a high outdegree)." (Jacomy et al., 2014 p.4). It gives greater visual and spatial importance to "popular" nodes rather than "engaged" nodes in the community.

The second algorithm implemented is called the *algorithm of Louvain*. It addresses the issue of communities' detection in large-scale networks. This algorithm consists of an iterative process including two steps:

"Assume that we start with a weighted network of N nodes. First, we assign a different community to each node of the network. So, in this initial partition there are as many communities as there are nodes. Then, for each node i we consider the neighbors j of i and we evaluate the gain of modularity that would take place by removing i from its community and by placing it in the community of j. The node i is then placed in the community for which this gain is maximum (in case of a tie we use a breaking rule), but only if this gain is positive. If no

positive gain is possible, i stays in its original community. This process is applied repeatedly and sequentially for all nodes until no further improvement can be achieved and the first phase is then complete […] The second phase of the algorithm consists in building a new network whose nodes are now the communities found during the first phase […] Once this second phase is completed, it is then possible to reapply the first phase of the algorithm to the resulting weighted network and to iterate […] The passes are iterated until there are no more changes and a maximum of modularity is attained." (Blondel et al., 2008, p.4).

In short, ForceAtlas2 visually distributes the nodes and links spatially while Louvain algorithm gives them a color based on their membership in one group or another (see figure 1).

Third, both algorithms outlined produce new linkages among digitally-mediated traces of our interactions. Like scripts (Sims & Gioia, 1986), the different calculations make it possible to model actions (i.e., publication, comment, sharing, etc.), to interconnect them in order to bring out knowledge about the interactions in the organization. From a narrative point of view, we consider that it writes a story of our digitally mediated interactions. If we paraphrase Giroux & Marroquin (2005, pp.18-19), the decontextualized sequence of logs means nothing in itself, it becomes significant only by the "intrigue" or "muthos" which gives meaning. The quest inscribed in the plot connects several actants, logs and users, around a context-dependent value object specific to the author of the algorithm or the reader of the generated story. This story becomes only accessible through a first rewriting process which helps to translate the structural proximities into visual proximities. As mentioned, this rewriting relies on a number of settings which can influence the story represented. Because interactions are interconnected and grouped under certain visual forms by the actions of these different scripts, these interactions take on a new and variable materiality in the story represented as a social graph. New because the sense created emerges from the calculation not accessible otherwise and variable because the relative importance of relations in the network can vary strongly depending on the configuration of the algorithm and also the temporality of data. More, the story rests on elements often far removed from those who presided over their creation. It is only when a new actualization occurs through the appropriation of this virtual and probably poor story that is can produce knowledge in context.

Nevertheless, this paper focuses on the factory of the analytical tool and will not address its actualization once the analytical tool gets used in organizational context. Hence, although the process continues, we do not know how other beings – related to the organizational context or the practice of the users – will sustain, more or less, the materiality of such and such traces of past interactions in present or future conversations. Moreover, even if certain interactions,

by this editorial process, acquire a certain materiality, its existence cannot be reduced to it. There are, indeed, potentially other communications *presentifying* (Cooren, 2010) them elsewhere in space and time.

Synthesis of our contribution

Drawing on the detailed analysis of the fabric of a social media analytical tool, this article highlights the explanatory power of a communication perspective on rationalities enacted by thinking infrastructures. First, considering the thinking infrastructure as an editorial enunciation allow us to see it a social process implying several beings that are not inert or without consequences. Second, we show that these beings have different modalities of interactions with each other and that these modalities of interactions influence the materiality of the digital traces of past interactions. Third, throughout the process, we demonstrate the fragility and variability of their materiality. In the sense of Cooren (2015), we highlight how traces, like things, come to exist and to last in a variable way depending on their abilities to pass through other beings.

Faced with the rise of technological deterministic discourse that tends to portray the exploitation of our digital traces as an objective way of representing the collaborative practices that make up the organization, our research aims, on the contrary, to demonstrate their relativity. In doing so, we also question their exploitation for the purpose of managing and stimulating collaborative practices within the organization. Similarly, in the era of big data, it warns and invites researchers in organization studies to question the nature of data, treatments and visualizations mobilized for research purposes.

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