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Data visualization as a qualitative driver in knowledge communication: an interpretative framework

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Abstract | The growing cultural relevance of data literacy requires a deeper acknowledgement and assessment of the role that data visualization can play if interpreted as a mean to increase the quality of information besides reporting its quantitative features, being therefore actively integrated within the current ecosystem of knowledge communication. In fact, while data visualization is often considered as a merely quantitative tool for information analysis and reporting, the methodologies underpinning this particular branch of visual communication go far beyond the simple restitution of numbers and sizes, frequently approaching more qualitative stances. Highlighting an implicit correlation between data visualization and qualitative research, the present contribution proposes an interpretative framework based on a set of five comparative analogies, in relation to which a same number of emergent fields of application for data visualization are identified, described, and contextualized.

KEYWORDS | DATA VISUALIZATION, QUALITATIVE RESEARCH, KNOWLEDGE COMMUNICATION, INTERPRETATIVE FRAMEWORK, COMPARATIVE ANALOGY

1. Introduction

Since the early years of the new millennium, alongside the massive acceleration occurring in the technologic system, a growing interest in investigating the role of visualization in the production, transmission, and dissemination of knowledge started to spread transversally within the international research community (Burkhardt, 2008).

Definable as the realm of knowledge communication, this now well-established disciplinary current has frequently pointed out the strong potential of data visualization – broadly intended as the visual representation of data through both analogical and digital means – in dealing with the surplus of information generated by contemporary society. In fact, the observation of recent trends in this field seem to testify how, despite a remarkable aesthetic diversity, many experiences tend to accomplish common principles and procedures, which "result in a type of emergent taxonomy [...] and reveal the initial building blocks of a new visual language" (Lima, 2013, p. 159).

Nowadays, the flourishing iteration of efforts aimed at codifying the syntax of this language, and addressing its widespread dissemination, represent a major cultural issue in terms of data literacy, since "in the information age the ability to read and construct data visualizations becomes as important as the ability to read and write text" (Börner, Bueckle & Ginda, 2019, p. 1857). For this reason, is important to emphasize how, while data visualization is often considered as a merely quantitative tool for information analysis and reporting, the methodologies underpinning this branch of visual communication go far beyond the simple restitution of numbers and sizes, frequently approaching more qualitative stances (North, 2006).

This attitude recalls quite impressively the domain of qualitative research, definition standing for an array of strategies shared by many academic disciplines "for conducting inquiry [...] aimed at discovering how human beings understand, experience, interpret, and produce the social world" (Sandelowsky, 2004, p. 893). More than with exact counts or measures, qualitative data analysis is concerned with the detection of meanings, concepts, definitions, characteristics, attributes, metaphors, symbols, and descriptions of things, constructing research outputs suitable for being returned according to interpretative, discursive and thematic paradigms.

This analogy, highlighting an implicit correlation between data visualization and qualitative research, represents the common thread of the present contribution, aimed at defining an interpretative framework suitable for evaluating data visualization, and its potential qualitative impact, in relation to the broader field of knowledge communication.

2. The growing relevance of data literacy

Is important to premise that, within the bounds of this reasoning, the notion of knowledge communication will be primarily understood in its role of fundamental human prerogative, as "the (deliberate) activity of interactively conveying and co-constructing insights, assessments, experiences, or skills through verbal and non-verbal means" (Eppler, 2007, p. 291). This interpretation reverberates in the ultimate purpose of data visualization, which resides in the willingness of formalizing – through the design of infographic outputs such as tables, graphs, charts, diagrams, maps, or similar – a common language able to communicate information across cultural, translational, and disciplinary boundaries.

Such an attitude gains even more significance in view of a technological system which has led in few years to "the datafication of everything" (Mayer-Schönberger & Cukier, 2013, p. 194), and where the increasing proliferation of new digital devices, networks and infrastructures endorses the possibility of mapping the world in a mostly quantifiable, analyzable and computable way.

As we are all surrounded by information operating at varying degrees of immediacy to our lives, becoming at the same time both data producers and data consumers, it is important to identify and develop the "competencies that make up the all-round talents of a visualizer as well as those required to be an efficient viewer" (Kirk, 2016, p. 385).From this point of view, data visualization designers should start to operate according to a stance which is not simply data-driven, but also and especially data-informed and data-aware (Tan & Churchill, 2018), being able to encode new ways to turn information into value, and define the best ways to address them to a particular audience.

At the same time, also qualitative researchers began to advance the claim for redefining the traditional methodologies employed in gathering, analyzing and summarizing data, in order to understand more deeply how these activities affect the general process of investigation in the midst of the "information explosion" (Major & Savin-Baden, 2012).

The growing cultural relevance of data literacy requires a deeper acknowledgement and assessment of the role that data visualization can play if interpreted as a mean to increase the quality of information besides reporting its quantitative features, and actively integrated within the current ecosystem of knowledge communication. In this sense, it is of paramount importance to emphasize the qualitative features of data, from "the most personal information that is essential for our physical survival to the most abstract form of information that encompasses our personal myths, cultural development, and sociological perspective" (Wurman, 2001, p. 160).

Moving from these premises, the essay outlines a range of analogical – rather than strictly logical – arguments to support data visualization designers in gaining awareness about their role in turning quantitative information into qualitative experiences, fostering more consciousness in dealing with the increasing complexity of the world we live in.

3. The qualitative value of data visualization

Since the most ancient times, the visual display of information has been practiced across an extremely wide range of disciplines – ranging from mathematics to architecture, from economy to medicine, going up to sociology, psychology, music, art, and many others – as a vehicle to address sector-specific epistemology. It is also because of this transversality that data visualization has struggled for a long time to find its own disciplinary status, which started to effectively establish only around the mid-nineteenth century, meeting the need for managing a growing amount of statistical units becoming more and more significant to understand modern society.

However, while in the last decades data visualization has largely focused on quantitative processes of exploration and analysis, some of its earliest examples were created to show and explain that "the elements to be transformed [...] were no longer just quantities and numbers, but qualitative and semantic elements as well" (Burgio & Moretti, 2017, p. 893).

If we consider the achievement of a balanced ratio between evidence and rhetoric as an essential requirement for translating data into meaningful representations, experts in the field require to develop both statistic and design knowledge, since "without the former, visualization becomes an exercise only in aesthetics, and without the latter, one of only analyses" (Yau, 2013, p. xi). In this sense, data visualization community is growingly stressing the need for its practitioners to adopt explanatory, beyond simply exploratory, strategies in their design approaches, aimed at detecting relationships that may be hidden by summary statistics, and communicating interpretative insights inferred from scrutinized data (Barlow, 2014).

In turn, the potential of incorporating data visualization in qualitative research also started to be acknowledged, firstly as a way for generating hypotheses and developing theory, and secondly a mean to give readers the possibility of seeing the author's meaning represented in more ways than just verbally and textually (Verdinelli & Scagnoli, 2013).

In light of these considerations, could then data visualization be considered as a qualitative driver in knowledge communication? To validate this perspective, an interpretative framework bridging together data visualization with the domain of qualitative research is proposed and applied pointing out a group of comparative analogies.

On the one hand, five methodological categories are borrowed from the most prominent traditions detectable in qualitative research, as masterly synthetized by John W. Creswell (2006) as:

- narrative approach
- ethnographic approach
- grounded theory approach
- phenomenological approach
- case-study approach

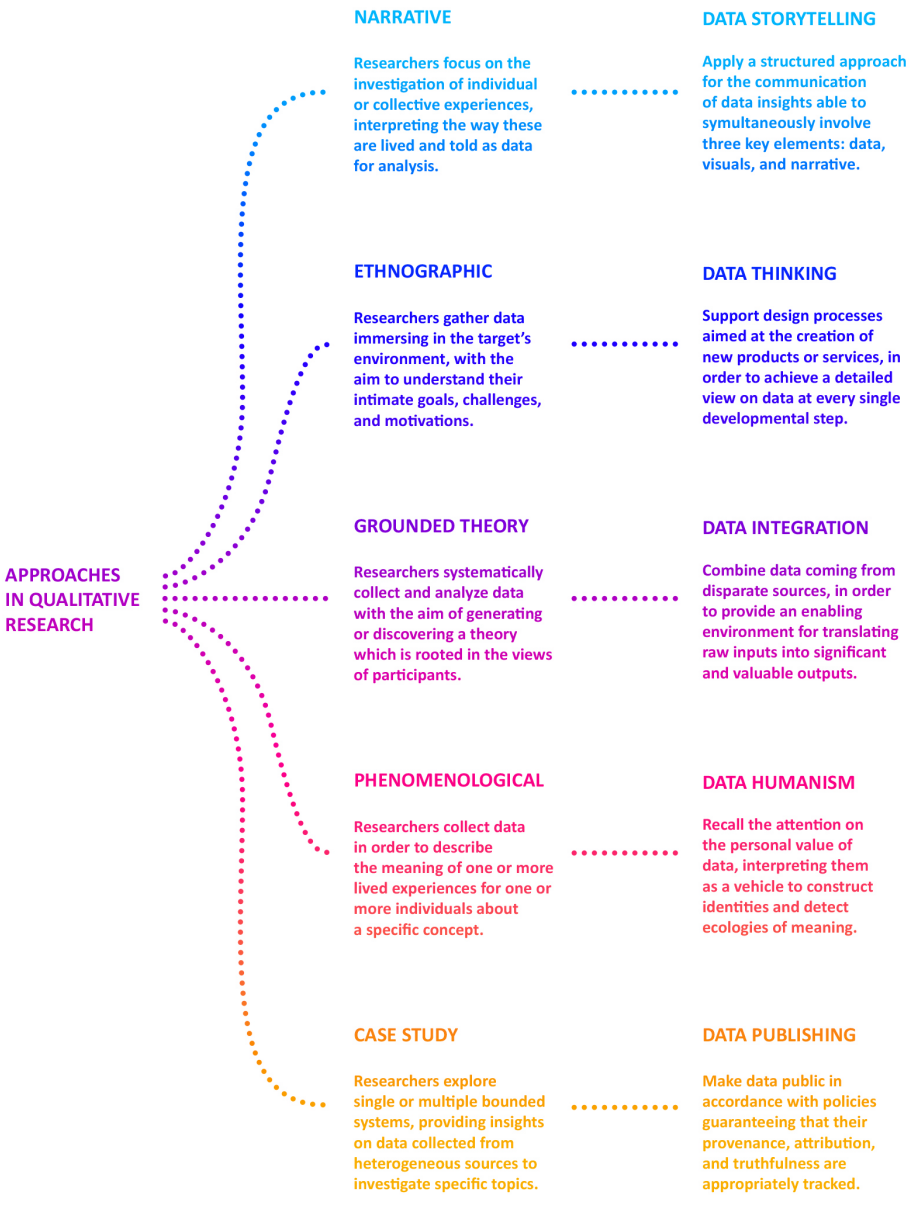

Figure 1. Schematic visualization of the framework proposed in the article.

On the other hand, the aforementioned categories are employed to identify, describe, and contextualize a same number of emergent fields of application for data visualization, emphasizing how these inherently promote a qualitative treatment of information:

- data storytelling
- data thinking
- data integration
- data humanism
- data publishing

3.1 Data storytelling

The first comparative analogy outlined in the proposed framework relates the discipline of data visualization to the qualitative mode of inquiry known as narrative approach, in which researchers focus on the investigation of individual or collective experiences, interpreting the way these are lived and told as data for analysis (Creswell, 2006). The procedures for implementing this methodology imply in the first place the collection, examination and interpretation of data in order to identify units and patterns of meaning, and afterwards the assemblage of those segments according to a clear narrative structure and a temporal – yet not necessarily linear – criterion.

This perspective, where a strong epistemological priority is assigned to the readability of research outputs, inherently points out the role of data visualization design in enhancing the sensorial and synesthetic features "that provide a narrative structure and guide the reader through the story" (Kosara & Mackinlay, 2013, p. 48).

In the last two decades, the narrative instance of data visualization has found an attainable and prolific field of application in the domain of data storytelling, a now diffused label identifying a structured approach for the communication of data insights involving a combination of three key elements: data, visuals, and narrative (Dykes, 2016).

Above all, data storytelling requests data visualization designers to deeply understand the distinguishing features of diagrammatic representation, being able to adopt the appropriate choice to convey specific information, and to translate them into both online and offline communication strategies (Lankow & Crooks, 2012). It is interesting to observe how strongly those competences would impact the treatment of data, since "whether genres are pure or mixed, words or graphics, ordered or not, every piece of discourse requires authors to select the information that is relevant, to express it felicitously, and to link the pieces into a whole" (Riche, 2018, p. 26).

Among the major expressions of data storytelling, one cannot omit the reference to the practice of data journalism, whose origins are traceable since the mid-twentieth century and which today represents one of the most important vehicles for the production of news stories, where visualization is structurally involved to highlight relevant topics.

A leading figure in this scenario is undoubtedly that of Alberto Cairo, Spanish information designer interested in the convergence between visual design and cognitive sciences, working in the field of data journalism since the early 2000s and currently director of the Visualization Program at the University of Miami's Center for Computational Science. In his PhD thesis, entitled *Nerd Journalism. How Data and Digital Technology Transformed News Graphics*, Cairo investigates "how news graphics has changed as a practice, as a professional endeavor, and as a set of products" (Cairo, 2018, p 17), redefining the search for a balance between the objectivity of representation and the aesthetics of communication.

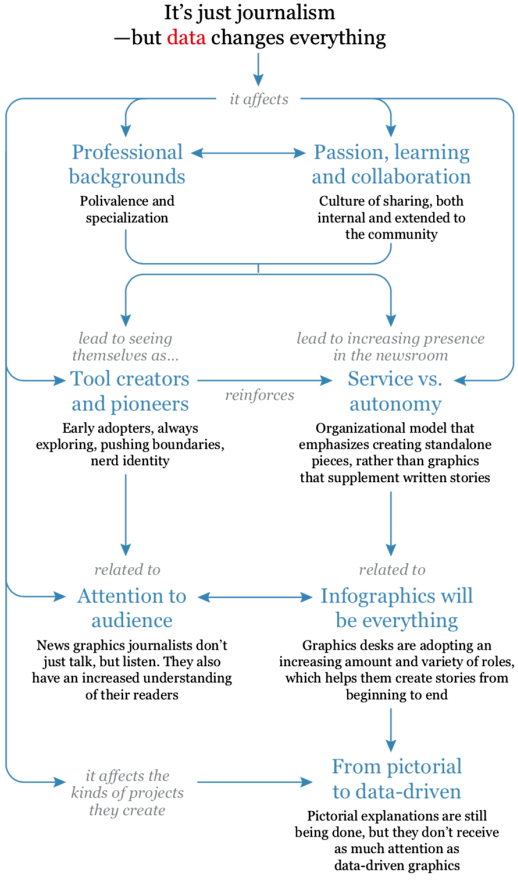

Figure 2. "Nerd Journalism. How Data and Digital Technology Transformed News Graphics", Alberto Cairo, 2017.

3.2 Data thinking

The second comparative analogy outlined in the proposed framework relates the discipline of data visualization to the qualitative mode of inquiry known as ethnographic approach, in which researchers gather data immersing in the target's environment, with the aim to understand their intimate goals, challenges, and motivations (Creswell, 2006). Drawing from a user-centered paradigm, this methodology interprets data as a vehicle of interaction and accessibility towards an entire group, domain, or society, in order to decrypt its shared patterns of behaviors, beliefs, and languages, and address contextualized experience within its cultural reality.

Such an attitude resonates in the principle according to which, to transform information into knowledge, data visualization "must share some context and meaning [...] to become encoded and connected to preexisting experience" (Vande Moere, 2012, p. 16), considering participants' social background, previous thoughts, distinctive abilities or disabilities.

In this sense, a promising field of application seems to be that of data thinking, a lately emerging concept identifying a range of strategies aimed at supporting design processes involved in the creation of new products or services**,** where the substantial purpose is to achieve a detailed view on data at every single developmental step (Kronsbein, 2019).

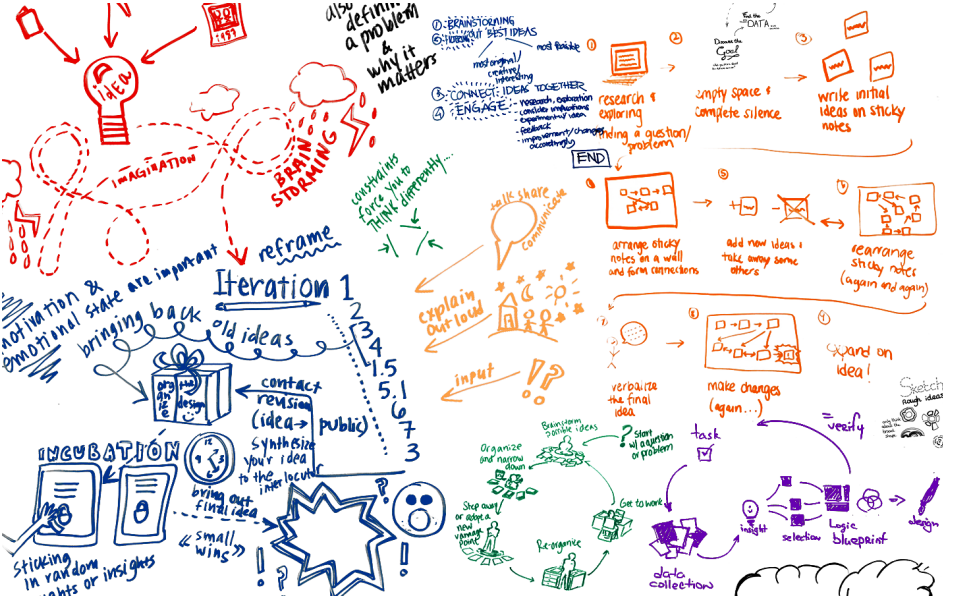

Figure 3. "Process Matters Workshop", Sense Information Design, 2016.

Understood as a symbiosis of design thinking and data science, the data thinking approach meets the instance for which, "designers need to address the impact of the increasing amounts of data available from a multiplicity of sources and […] inform how decisions are made" (Newman, 2017, p. 25). This acknowledgement assumes even greater significance if we consider how, in the face of an often-overlooked set of analytical skills, many data practitioners are too focused on accomplishing the usage of specific tools and techniques and not concerned enough with asking the right questions: put the why before the how (Shron, 2014).

Although the concept of data thinking is currently mostly affirmed in the business world, it offers insightful perspectives for addressing more widely the practice of data visualization to better understand people's mental models, and increase users' involvement while designing accessible interfaces, interactions, and experiences.

From this point of view, it is particularly significant the approach carried out by the designer and researcher Sheila Pontis, interested in mapping complex data through discerning "what type of information would be more helpful for the intended audience to be displayed in a visual explanation, and with what level of detail" (Pontis, 2018, p. 111). Together with Michael Babwahsingh, in 2013 Pontis founded Sense Information Design, a New York based design consultancy promoting a deeper understanding in all aspects of collaboration and communication, through people-centered experiences aimed at turning complex and unfamiliar messages into useful, meaningful information.

3.3 Data integration

The third comparative analogy outlined in the proposed framework relates the discipline of data visualization to the qualitative mode of inquiry known as grounded theory approach, in which researchers systematically collect and analyze data with the aim of generating or discovering a theory rooted in the views of participants (Creswell, 2006). Compared to the previously introduced ones, the intent of this particular approach is to move beyond the purpose of basic description, pushing towards the grouping of unstructured sources into concepts, categories, and codes, to obtain an analytical schema of a process that contributors have personally experienced.

Such perspective is particularly suitable for framing data visualization into the digital ecosystem, where the design process became deeply intertwined to an array of techniques – such as those of data acquiring, parsing, filtering, mining, representing, refining, interacting (Fry, 2008, p. 5) – which not necessarily involve direct manipulation of visible features.

This assumption paves the way for advancing a connection with the concept of data integration, designating the operations of combining data coming from disparate sources, in order to provide a unified view of them and an enabling environment for translating raw inputs into significant and valuable outputs (Roth, Wolfson, Kleewein & Nelin, 2002). Although drawing mainly from computer sciences and information technology, this concept

is indeed strictly related to data visualization, intended as “the process of making data intelligible, enabling human intuition and expert knowledge to be applied in areas where algorithmic interrogation is unrealistic” (Pettifer & Attwood, 2013, p. 519).

Since data integration establishes itself on a strong principle of collaborative community, where data and the tools for their processing should be mutually shared between users, data visualization can actively contribute to the release of participated theories that are both iterative and reflexive, both contextual and conceptual (Knigge & Cope, 2006).

Involving operational methodologies at the intersection of machine learning, database systems, and business intelligence, the field of data integration purposely requires data visualization designers to become acquainted with competences usually more concerned with profiles such as those of coders, statisticians, or engineers.

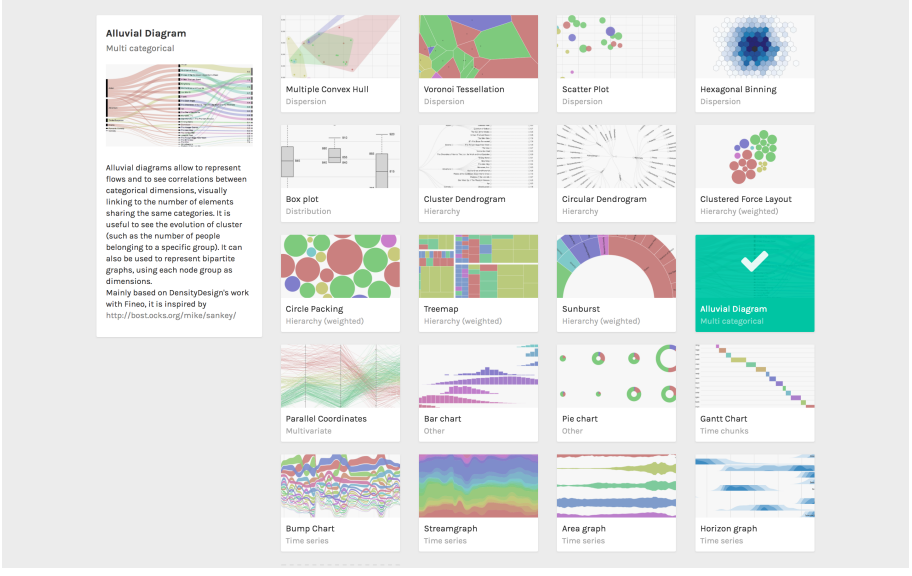

Figure 4. “RAWGraphs”, https://rawgraphs.io/

In this perspective, one of the most prominent examples is that of RAWGraphs, an open-source web application for the creation of static and dynamic infographics developed since 2017 by the DensityDesign Lab at the Polytechnic University of Milan, building upon previous work on visualization tools, libraries and platforms. Strongly relying on concepts such as open outputs, reusable charts, and community building, RAWGraphs defines a set of instructions for the creation of specific representations, giving users the ability to change the underlying data and customize their graphical variables (Azzi, Caviglia, Elli, Mauri, Uboldi, 2017).

3.4 Data humanism

The fourth comparative analogy outlined in the proposed framework relates the discipline of data visualization to the qualitative mode of inquiry known as the phenomenological approach, in which researchers aim to describe the meaning of one of more lived experiences for one or more individuals about a specific concept (Creswell, 2006). In comparison to the narrative approach, before than the translation of unstructured data into a story, the fundamental goal of this methodology resides in describing the essential nature of a particular phenomenon, deriving significant arguments and statements about its meaning from evidence provided by those who personally experienced it.

Figure 5. "Dear Data", Giorgia Lupi and Stefanie Posavec, 2016-2017.

If transposed to data visualization, a similar stance suggests the enactment of a methodology in which the design process draws from deeply understanding the causes, consequences, influences and projections referred to a given circumstance, in order to display its connection and significance in relation to everything else (McCandless, 2014).

Such consideration closely intercepts the theoretical dimension of data humanism, which is rooted in the recognition of the interpretative nature of visualization towards the phenomenal world, as "the display itself is conceived to embody qualitative expressions, and the information is understood as graphically constituted" (Drucker, 2014, p. 129).

Standard analysis procedures could lead data practitioners to give priority to numbers before people, losing sight of the most important characteristics which address human beings in gaining self-awareness and developing emotional intelligence: creativity, drive, persistence, motivation, rapport, and empathy (Goleman, 2011). The instances underlying the current of data humanism recall the attention on the personal value of data, interpreting them as a vehicle to construct identities and detect ecologies of meaning, privileging the investigation of small, consistent, and detailed matters rather than big, uneven and scattered ecosystems (Georgakopoulou, 2007).

These are, in short, the foundations and purposes that lay the groundwork for applying a humanistic approach to data visualization, aimed at contextually depicting the uniqueness of phenomenons pertaining single individuals' experiences through the graphical representation of their intimate, speculative, and even poetic relationships.

Exemplary, in this perspective, is the work of Giorgia Lupi, Italian information designer and partner at Pentagram Studio, according to which "we are ready to question the impersonality of a merely technical approach to data and to begin designing ways to connect numbers to what they really stand for: knowledge, behaviors, people" (2017). *Dear Data*, probably the most renowned work by Lupi, is a year-long drawing project carried out with Stefanie Posavec: each week, during a year, the two designers collected and measured a particular type of information about their lives, and used these to make a drawing on a postcard-sized sheet of paper, approaching data visualization in a slow, analog, and artisanal way.

3.4 Data publication

The fifth comparative analogy outlined in the proposed framework relates the discipline of data visualization to the qualitative mode of inquiry known as the case study approach, in which researchers explore single or multiple bounded systems, providing accurate, detailed, in-depth insights on data collected from heterogeneous sources (Creswell, 2006). Since the case study approach might loosely select to investigate specific topics drawing from several source, or multiple topics housed within a single source, some disagreement exists about whether this methodology should be considered as an effective type of qualitative research, or instead as an object of study, or even as a product of the analysis.

Dealing with sources is a prominent issue also for what concerns data visualization, since inadequacies in their scientific accountability could lead to misleading or disempowering aspects, such as lack of transparency, merely extractive collection, technological complexity, and deficiency in the control of impact (D'Ignazio & Bhargava, 2015).

In this sense, relevant instances have lately been pointed out by the emerging research field of data publishing, a practice through which data are made public in accordance with associated policies guaranteeing that their provenance, attribution, and truthfulness are appropriately tracked (Candela, Castelli, Manghi & Callaghan, 2017).

Although a general agreement is still to be reached, the academic community started to recognize the need to define specific standards aimed at documenting and referencing the processes underlying the publication of data (Austin, Bloom, Dallmeier-Tiessen, Khodiyar, Murphy, Nurnberger, Raymond, Stockhause, Tedds, Vardigan & Whyte, 2016) In parallel, many important companies, organization and institutions throughout the world have extended their corporate image systems to include guidelines specifically calibrated for the visual display of information, acknowledging "the growing importance of using data [...] and the value of branding them appropriately" (Cesal, 2019).

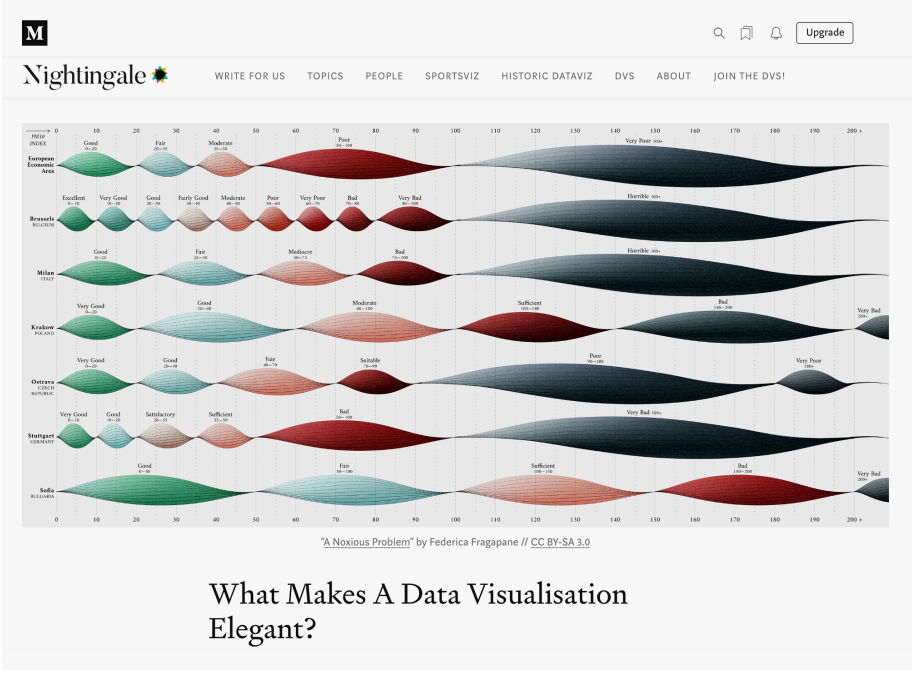

Figure 6. "Nightingale – Journal of the Data Visualization Society", https://medium.com/nightingale

Although their formalization into more codified principles is still in progress and mostly empirical, these signals warn us about how the massive spreading of data visualization across analog and digital media calls for an institutional environment able to supervise the circulation of information and establishing protocols for its usage on a case-by-case basis.

Remarkable, in this sense, is the work recently carried out by the Data Visualization Society, instituted in 2018 by Amy Cesal, Mollie Pettit and Elijah Meeks in order to "address that lack of professional development in the field, create a larger community, and [...] establish guidelines for professional development" (Meeks, 2019). The Data Visualization Society has also founded *Nightingale*, a digital journal based on the *Medium* publishing platform, with the aim to provide high-quality daily articles covering many aspects of data visualization, including education, entertainment, history, sports, best practices, new techniques, and many other.

4. Conclusions

In conclusion, the framework proposed in this dissertation seems to confirm the hypothesis of an inherent correlation existing between the practice of data visualization and the domain of qualitative research, reciprocally concerning both their underpinning theoretical assumptions and the methodologies applied for investigation purposes. The revealed analogies appear consistent and pertinent, as the corresponding fields of application put forward relevant issues about data – such as those related to their readability, accessibility, usability, personality, and accountability – opening insightful perspectives for practitioners involved in this disciplinary and professional field.

More generally, the involvement of visual semantics can act a powerful mean for leveraging the cultural value of information in order to enhance the spread of data literacy, and is mainly in this sense that data visualization could be intended as a qualitative driver in the processes of generating, organizing, and communicating knowledge.

At the same time, the outlined framework presents also several questionable criticalities, as in the first place the limited number of design examples presented in relation to the five identified categories, which amount could be enriched and implemented with additional references that may have not been here considered. Furthermore, as already mentioned in several passages of this contribution, the arguments upon which the framework itself is articulated rely on an overtly interpretative stance: an aspect, this, which would necessarily imply further inquiry to appropriately validate the effectiveness of the advanced classification.

In any case, this study has provided presumptive evidence to affirm that promoting and enhancing occasions of cooperation, contamination, and fertilization between the fields of data visualization and qualitative research could lead to account the shift from a paradigm founded on data accumulation to one oriented to data signification.

A greater involvement of qualitative research procedures in data visualization would encourage the latter in developing a deeper inclination towards incorporating principles of understanding, participation, cooperation, empathy, and openness, as well as a stronger proclivity in operating in contexts and conditions of uncertainty. Data visualization, in turn, could contribute to the realm of qualitative inquiry by offering a design-oriented perspective, aimed at providing ad-hoc formats and layouts to support researchers in organizing informational contents, as well as at arranging visual shortcuts for helping them in exploring their data more effectively.

More comparative research focused on this specific, intertwined analogy would definitely be welcomed and recommended, acknowledging how the quest for a broader theoretical systematization could contribute to address data visualization in fully unleashing all its communicative, cultural, and ultimately qualitative potential.

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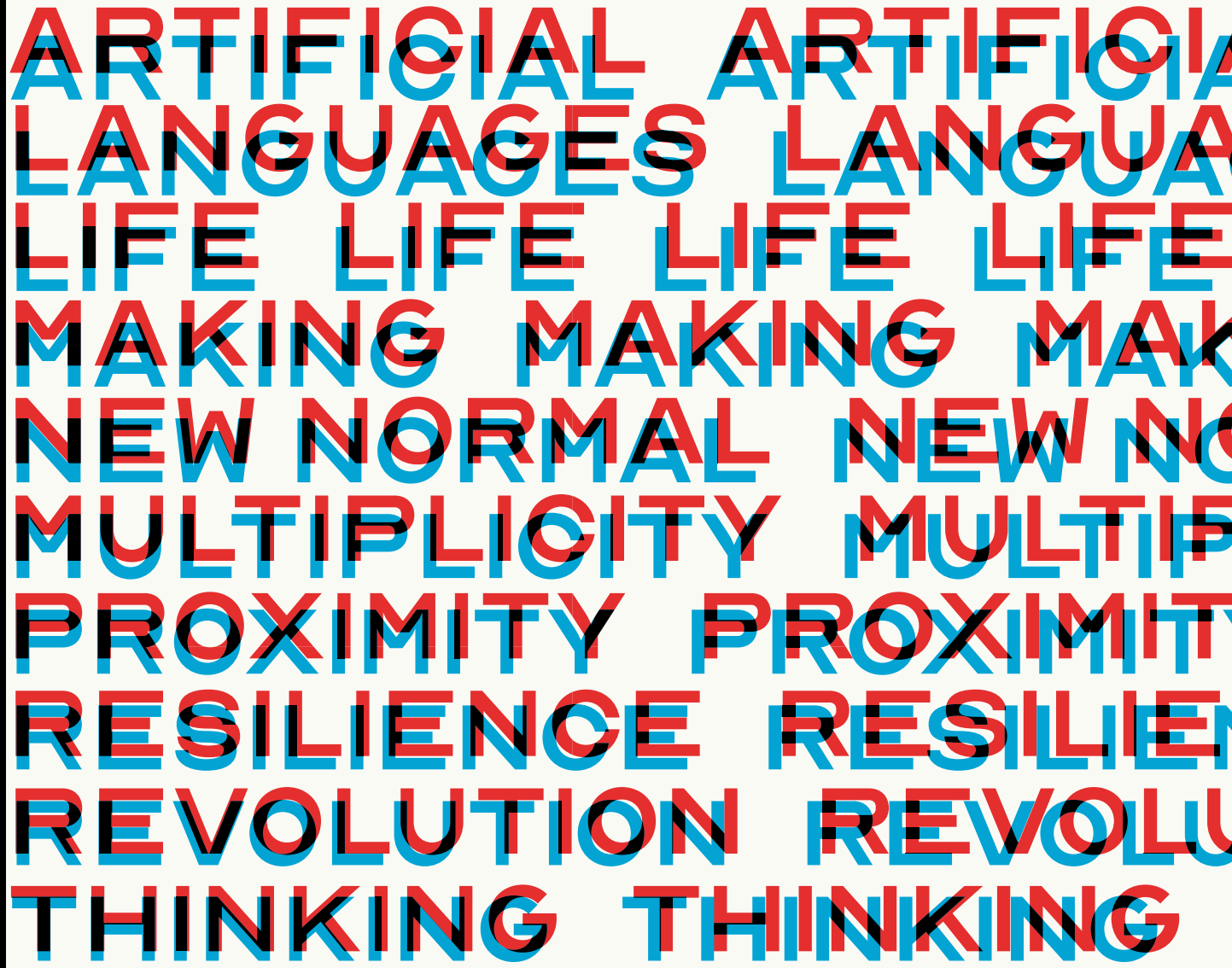
Giulia Ciliberto gained her PhD in Design Sciences at Iuav University of Venice, where she is currently hired as research fellow. Her research interest resides in the investigation around the elementary principles underlying the disciplines of design and visual communication, in theory, practice, and education.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LIFE
MAKING
NEW NORMAL
MULTIPLICITY
PROXIMITY
RESILIENCE
REVOLUTION
THINKING