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Metaphors as Knowledge Activators in Data Visualizations: the case of the Archipelago of Calvino's literary works.

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Abstract In this paper we present the outcomes of a collaboration between scholars and designers aimed at exploring the potentials of data visualization in support to the creation of literary critique. By exploiting action research, we envisioned a methodological integration between data visualization, design and literary critique aimed at the representation of humanistic data and knowledge. In our work we made an extensive use of the visual metaphors (the natural landscape), with the aim of activating domain experts' knowledge and externalizing inconsistent and ill-defined information. In conclusion we argue that similar methodological integrations are important contributions that communication designers can bring to the field of Digital Humanities.

**KEYWORDS | DIGITAL HUMANITIES, DATA VISUALIZATION, VISUAL METAPHORS,
KNOWLEDGE ACTIVATION, ITALO CALVINO**

1. Introduction

The work presented in this contribution lies in the field of Digital Humanities (DH): a multidisciplinary area of study, research and teaching where humanistic disciplines and computing come together (Caviglia, 2013). This context is multidisciplinary by definition and can see the collaboration of researchers coming from very different backgrounds.

In this contribution we present the case of literary scholars and information designers using data visualization to comprehensively represent the narrative production of the Italian writer Italo Calvino. The specific challenges related to this case study are addressed in section 3 (and in particular in 3.1 Goals and Challenges). Hereafter authors will introduce their approach to data visualization for Digital Humanities and the aim of this research.

Data visualization and its practices have been used in several fields during the last decade (D'Ignazio, 2018). This is due to their capability to give shape to complex phenomena and to make them accessible both to general public and domain experts. Humanities are no exception and have been experimenting similar practices, at times leading to interesting and meaningful results (Moretti, 2016), at other times pointing to challenges or mismatches (Marche, 2012. Posner, 2015, Uboldi & Caviglia, 2015). In fact, as Druker states, practices of data visualization had sprung from disciplines such as statistics, empirical sciences, business and have been shaped by them according to their needs. Being those disciplines so different from Humanities, data visualizations need to assess a process of critique and adaptation in order to support humanistic inquiry, a process that gives priority to interpretation, ambiguity, inference, and qualitative judgment over quantitative (Drucker, 2014).

Such 'loose' and 'ill-defined' humanistic approach to inquiry can be partly explained by looking at materials of study of scholars: they usually do not work with quantifiable information but with much more complex matters, that they want to put in relation with culture or human history.

In this context it is very difficult to perform measurements or categorizations (Posner, 2016) and then build data visualizations. Part of the reason is due to the fact that scholars are very much interested in singularities and details (Caviglia, 2013) and not just in the "big picture". Furthermore, their materials of study are most of the times incomplete, because damaged or just because impossible to be collected in their completeness (Marche, 2012).

The aforementioned considerations are very general and present a nuanced significance depending on the specific object of inquiry. However, it is of paramount importance to acknowledge them, because they put in the foreground the fact that human ability to understand and interpret cannot be directly combined with computers' ability to analyze massive datasets (Hall, 2013). Computation would come at the cost of reduction and many scholars are reluctant to this loss because it affects their possibilities of contemplation and of identification of connections. Additionally, not every scholar is interested in leveraging the power of technologies to cope with big data and emerging patterns. Instead, they prefer to work with a delimited corpus of documents, that is operable with their traditional tools and

methods. Even if not interested in big data, those scholars still manifest an interest in better understanding data visualization and adopting it within their workflow.

“Is data visualization supposed to help such scholars in their work? How?” This is the question behind the presented contribution, in which designers inquire the production process of data visualization for DH through the iterative process of action research (Swan, 2012; Muratovski, 2016; McCurdy, 2016).

2. Related works

From the perspective of data visualization, it is possible to identify projects that individually focus on some of Calvino's most famous works: *If on a winter night a traveller* (Piotrowska, 2019) and *The invisible cities* (Gianordoli, 2017). Given the combinatory structure of its index, this last book has also been used as case study to design an interactive tool aimed at performing multi-level readings (Van den Heuvel, 2016).

More generally, visualization has been previously used to represent individual written works of any genre. Very well-known is the work of Ben Fry (Fry, 2009) *On the Origin of species* and the same applies to Moretti's analysis of Shakespeare (Moretti, 2011), or Grayson (Grayson, 2016) analysis of Arthur Conan Doyle, Jane Austen and Charles Dickens.

When we consider the visual representation of corpora of written documents, it is possible to identify many examples that represent documents as elements in a virtual space (Wise, 1996. Chalmers, 1993. Hall, 2013). Even if documents do not inherently have spatial attributes, they are assigned coordinates via computational means so to create a visualization that metaphorically represents a natural landscape. As a consequence, information about individual documents or groups of them can be learnt from their distances and proximities in the landscape, thanks to everyone's intuitive understanding of it (Figure 1 and Figure 2) (Fabrikant, 2009).

Using a landscape metaphor, or simple cartesian spaces, it is a common strategy used to visually make sense of documents collections. Yet, the ways in which we can calculate elements coordinates are not flawless. In fact, it is occasionally enhanced with human interventions (or human in the loop or touch-ups) in cases in which domain experts notice problems with the overall image produced through the computational means (El-Aassady, 2019). In such cases visualizations manifests their capability to elicit experts' knowledge by contrast between what they know about the considered topic and what they see in the visualization itself (McCurdy, 2019).

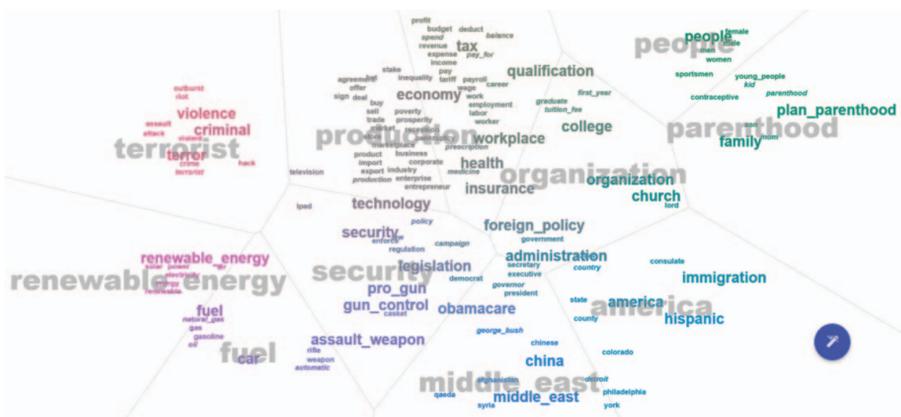


Figure 3. Results of Topic Modelling are manually refined with experts' interventions aimed at repositioning elements in the space. In this way, users' knowledge is incorporated into the visualization.

Despite the described examples, it is rare to find cases focused on a comprehensive representation of the production of an individual writer. In regard to Italo Calvino, it is possible to find cases that attempted to represent the author's most important volumes on a timeline¹ or the combination and re-combination of author's short stories into collections².

The publishing house Arnoldo Mondadori released during the 90s the most comprehensive collection of the written works of Italo Calvino. This collection consists in six volumes part of the series "I Meridiani" and gathers: narrative texts (novels and short stories), essays, letters and other forms of writing. At the time of writing there is no trace of a project that attempts to visually represent the author's narrative production as a whole. The presented case study is a step towards the fulfillment of this specific gap.

1 Visualization *Il tempo e le opere* in «La Lettura», n. 368, 16 dicembre 2018, pp. 16-17

2 Visualization *Il flusso dei racconti* in «La Lettura», n. 358, 7 ottobre 2018, p. 16

3. Case study

3.1 Goal and challenges

The presented design artifact is realized in the context of a research project where literary scholars and information designers work together to experiment on new ways to use data visualization in support to the creation of literary critique and to the representation of humanistic knowledge. The production of the Italian writer Italo Calvino serves as use case.

Our main goal was to produce a visual representation of all Calvino's narrative writings, a corpus of 229 titles which includes records for novels, short stories, and collections of short stories. Essays, reviews, letters and rewritings of the author were deliberately kept out by scholars' decision. The resulting visualization was supposed to be a tool for literary scholars, and it is designed to help them in the process of producing literary critique.

In a first place, the representation of the corpus is a challenging task because data in itself is very heterogeneous. A novel is very different from short stories: the former is a book while the latter could be only a few pages long. Collections appear very similar to novels, in the sense that they are volumes, but in fact they are different in their essence and are nothing more than the grouping of many short stories. Short stories that are part of collections were selected upon author's artistic taste and his tastes about themes, styles of writing, experimentations, political and cultural influences and many other aspects.

Moreover, short stories can be released on magazines or newspapers and then be published into one or more collections. As a consequence, they can present multiple publication dates and the earliest is not necessarily the most important from scholars' point of view. To represent in a single visual artifact all those heterogeneous and ambiguous elements and properties is certainly the first challenge to cope with.

Secondarily, the visualization ought to take into account author's different periods (political, cultural and artistic), that are very relevant aspects, but are very difficult, if not impossible, to be quantified. In fact, commonly used analysis strategies such as NLP (Natural Language Processing) are not able to grasp such information. They are able to quantify features of the text or even to provide summarizations, but to do so they break up the text in individual entities. Literary choices made by the author reside in details like the pairing of particular words, images, rhetorical figures and other literary instruments that get destroyed in this computational process, also named 'bag of words model' (Zellig, 1954). For this reason, the second challenge lies in the identification of a method to make such aspects emerge and become visible.

The researchers involved into the project identified a solution based on a methodological integration (Kelle, 2007) between quantitative and computational approaches proper of data visualization and qualitative and speculative ones proper of design (DiSalvo, 2012).

3.3 Design process

The design process of the presented visualisation followed a strongly iterative process. Several intermediate results were produced and evaluated in order to understand how to proceed. This process resembles the one of action research (Swan, 2012. Muratovski, 2016. McCurdy, 2016).

To quickly bootstrap the project and test hypotheses, we started using known solutions and tools. Specifically, we started from a *contour plot* visual model made in RAWGraphs (Figure 4) and we then modified it in Adobe Illustrator (Figure 5 and 6).

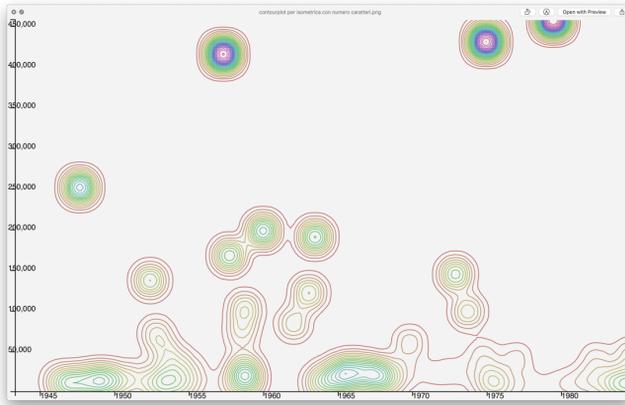


Figure 4. The contour plot was generated within RAWGraphs, using the first publication date on the horizontal axis and texts length in characters on the vertical one.

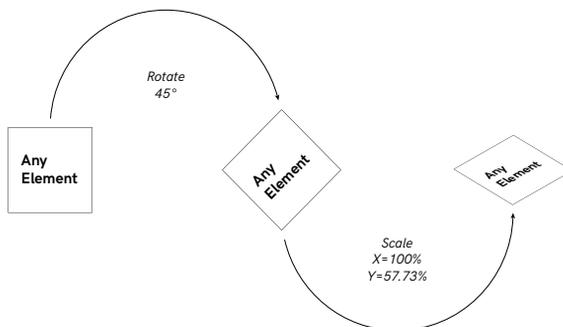


Figure 5. The isometric transformation performed on the contour plot.

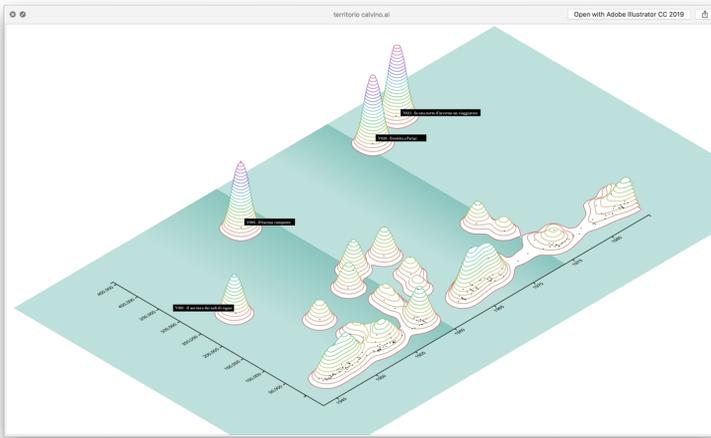


Figure 6. *The first attempt to produce a visualization capable of resembling a territory.*

In this attempt, the visual resemblance with a hilly territory was visible and the metaphor of a natural landscape was operative already. However, the visualization wasn't effective yet. In fact, precisely because of the metaphor, scholars perceived as inappropriate the position of many elements that happened to be closely positioned in the space. Those texts didn't share anything if not a similar length in characters and first publication date. Moreover, this resulting visualization didn't display all texts as singular graphical elements because some of them result merged in the same morphological agglomerate (Figure 7).



Figure 7. The first visualization of the territory was not effective since it grouped the texts according to their length in characters and date of first publication, often merging texts that overlapped into morphological agglomerates. This relationship did not allow all the texts to be seen and was not meaningful for representing the entire corpus of Calvino's literary work overtime.

The metrics we used to produce the contour plot brought many works to be close in the space without paying consideration to important aspects such as texts stylistics or their importance to the author. Even if such features cannot be directly quantified and visualized, other information could be used to indirectly display them: by looking at this first visual attempt researchers decided to experiment with a displacement of elements based on collections.

If compared to dates and other metrics, this information is less quantitative and less comparable but, at the same time, is more informative and more authorial. Indeed, the fact that a text is part of one or more particular collections, tells much about its framing into the writer's career, its importance, its stylistics and other aspects that are particularly relevant to a domain expert.

Collections can be seen as partially overlapping groups of texts, kept together by the relationships among themselves. In other words, we can imagine drawing a link between every pair of texts that appear in the same collection. This operation results in a network structure. Since network graphs are visual tools suitable for representing such kind of information, data was visualized into Gephi (Bastian, 2009) as an un-directional force layout graph, with nodes spatialized with a Fruchterman-Reingold (Fruchterman and Reingold, 1991) algorithm and sized according to their length. Nodes coordinates were subsequently extracted and used to produce the contour-plot model of RAWGraphs and the resulting SVG was reworked with a vector editing software to "reboot" the metaphor of the landscape.

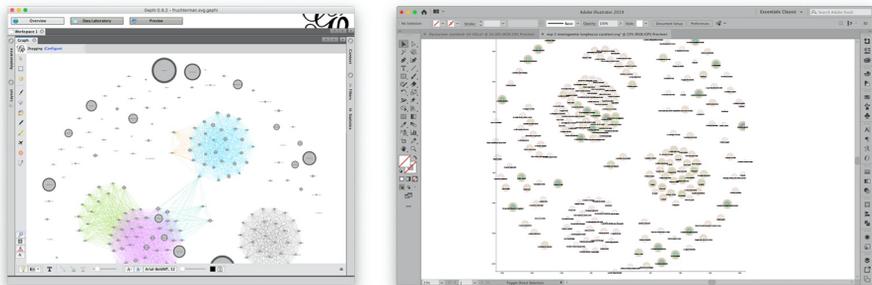


Figure 8. Gephi was used to position the texts in a space where the relationship between them and their chronology were significant (image on the left). Then, the coordinates of the nodes were used to produce the contour-tracing model and recreate the landscape metaphor (image on the right).

From this second result it is clearly visible the fact that writings could present very different behaviours and not all of them were published into collections. According to the visualised data, novels were all the time published independently and many stories were released only on magazines. Fruchterman-Reingold algorithm worked well for depicting that part of the territory occupied by connected elements: the closer they are in the space, the higher the number of connections they shared. However, the chronological dimension was almost completely unreadable, and the position of unconnected nodes is assigned randomly.

Again, reading the placement of texts through the metaphor of the natural landscape suggested the idea that some of their positions were meaningful, while others were inappropriate and needed to be fixed. A proper territory in fact, needs to present a morphology that could be read in a consistent way across all of its elements (Figure 9).

The metaphor, in fact, is capable of activating brain abilities of pattern recognition and spatial reasoning that are innate in humans; therefore, the reading of the visualization takes advantages of pre-attentive processing and ease the burden on attentional resources (Wise, 1995).

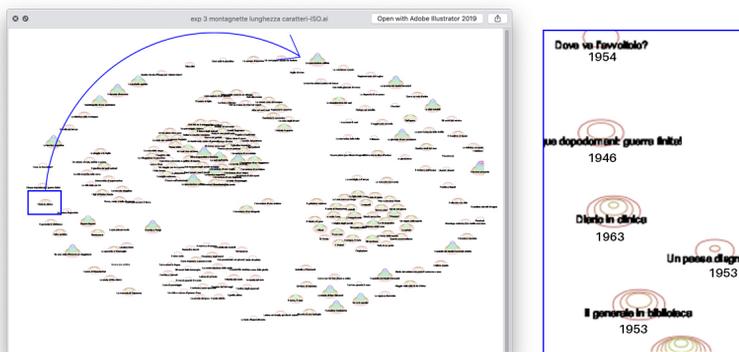


Figure 9. The computational position did not correctly represent all the nodes. In some cases, as shown in the image, the algorithm privileged the relation variable over the temporal variable or vice versa. The text “Diario in clinica” published in 1963 should be placed next to the other texts of the decade.

The position of those misplaced nodes needed to be modified, but it was not possible to identify any rigorous –or computational– method for doing so. For this reason, the team decided to adopt a solution based on a qualitative intervention on the visualisation: to touch-up the positions assigned by the spatialization algorithm, manually suggesting where elements should appear in the space (Figure 10).



Figure 10. Many drafts were printed and manually annotated to decide how to fix anomalies in elements positions.

In an iterative sequence of transformations and evaluations, isolated nodes were grouped by years of first publication and successively scattered around the main islands of Calvino's collections, following a circular shape. Also, some nodes of the collections were at times repositioned, assigning a better position according to scholars' reflections on chronology and their reading of the territory. Position of nodes became relevant, allowing to read and understand the logic of this territory as a whole.

Nodes coordinates were once more retrieved from Gephi, but instead of using the contour-plot model of RAWGraphs, a custom interactive representation was produced using D3.js (Bostock, 2011).

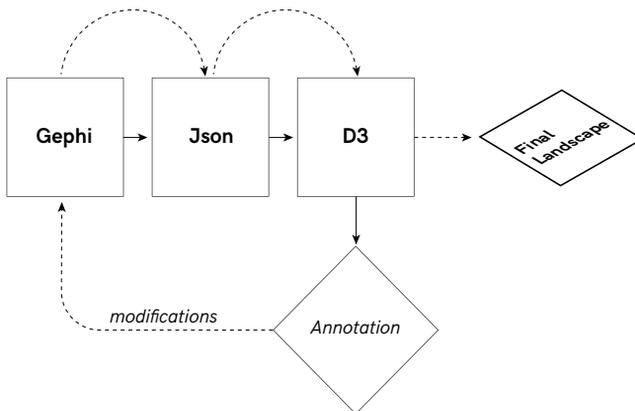


Figure 11. The iterative work of design, evaluation and adjustment of the nodes started with the use of network modelling tools (Gephi) to obtain the coordinates of the nodes (Json) and their visualization using the D3.js library. This computational process was evaluated by humanists, who modified the calculated positions of elements drawing from their knowledge.

After the review and annotation process, the process was repeated, altering the result according to the manual intervention.

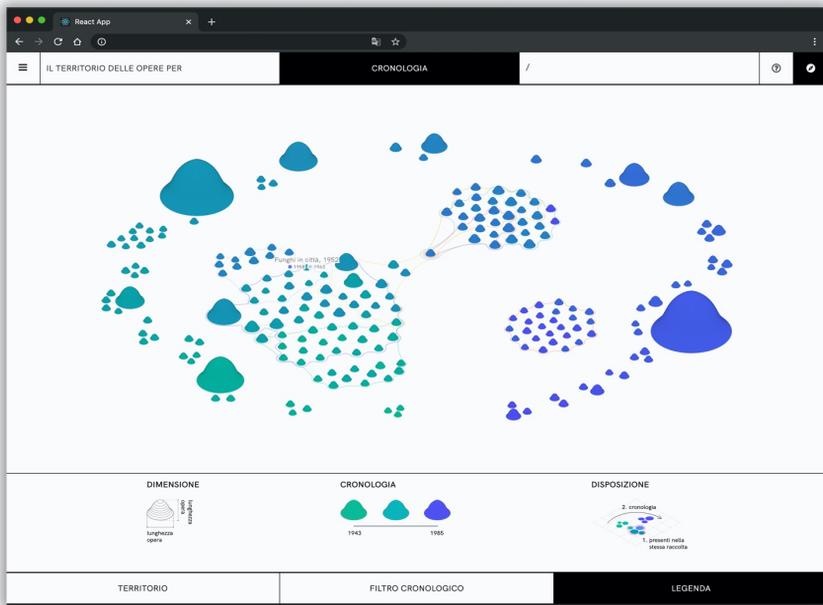


Figure 12. The final landscape is inserted in an interface that allows the exploration of the texts. In the image, the colouring of the "mountains" in the landscape represents the chronology from green (1943) to blue (1985).

3.4 Outcomes

The Archipelago of Calvino's Literary Works has been made available mainly in the form of an interactive webpage, with the possibility to search, filter, zoom and pan as if the visualization were a real interactive map of a territory³.

Visualisation presents three islands surrounded by a big ring of smaller ones (Figure 12). Islands represent elements that are kept together by collections, whereas external ring is composed by the remaining written works, those that were not part of any collection. External elements have been manually scattered around according to first publication dates

³ Find the visualization at: <http://atlantecalvino.unige.ch/>

and by following a clockwise direction that starts from the south of the Landscape (its central-bottom part).

For the elements part of the first island (the biggest, on the central-left portion of Figure 12), chronology had been partly sacrificed in favour of the grouping in collections. Still a general sense of time emerges from the artwork, because dates had been fuzzily taken into account in the manual orientation of collections and elements (Figure 13).

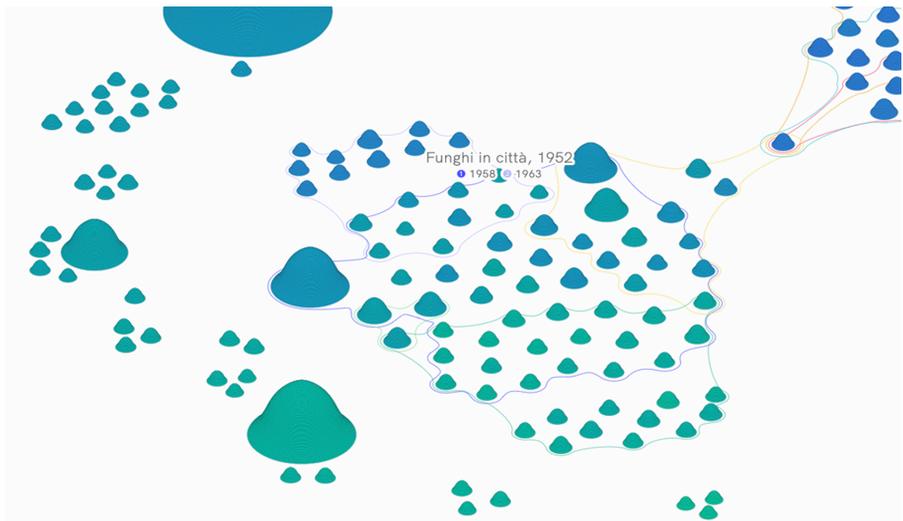


Figure 13. Detail of the first island: elements at the bottom are mainly green (older) than elements at the top, which are mainly blue (newer). Elements in the center are positioned according to a compromise between date and membership to collections. The position is the result of scholars' intervention.

The visualisation provides an immediate overview of all of Calvino's written works creating a nearly physical sensation of typologies and quantities. The diameters of collections oppose the elevation of novels, suggesting the idea that short stories are an important area covered by the author's production over his forty years long career.

The visualization also shows the multiple acts of re-mixing that the author performed on his own stories, together with the fact that earlier collections were less compact and more chaotic than the later ones. This is clue of the writer experience and awareness developed during the years.

4. Discussion

The process of creating literary critique is based on memory efforts and on scholar's capabilities of creating connections with culture and human history. The process of creating data visualization is usually based on quantifications and generative representations. This contribution reports on a viable way to integrate the two methodologies in order to design visual representations that are partly based on quantitative data and partly based on experts' elicited knowledge.

It is not unknown that that the realization of data visualization is a biased process (Kirk, 2016) which includes many choices that influence final outcomes. When creating the visualization discussed above, a key aspect had been to decide consciously on what to visualize among the many different data available and, once done that, to decide not to completely trust the result provided by the machine.

As described earlier, quantitative and comparable metrics were dropped in favour of the inconsistent and ill-defined information about collections. Although not an immediate decision, it is interesting to notice that this information is a direct result of Calvino's decision and presents an evident curatorial nature. Moreover, being so loose, it was the data dimension that less prevented scholars' tacit knowledge to emerge. The monographic setting in which this work had been carried out calls in fact for a deep understanding of the author's corpus through his personal history, his periods of break, his personal milestones, his professional achievements and the influence of external factors (like World War II and Partisan Resistance).

Some parts of that information could be derived, some others could be potentially embedded, but many others appeared as too complex to be fit into data. This explains the fact that metrics were too superficial to address needs of scholars, even if they perfectly fit the available tools for data visualization that are currently available.

This case study proves that visualization designers have to learn how to deal with ill-defined and incomplete information, even if it is hard to be exploited properly within data visualization tools. Precisely because of this fact, communication designers find themselves into an advantageous position if compared to other practitioners involved in data visualization, thanks to their expertise of manipulating graphics and images.

In the reported case, the use of a visual metaphor proved to be a particularly useful strategy, not only because it helped in the intuitive understanding of the visual outcomes, but mostly because it nurtured acts of speculation, pushing experts to ask the question: "where should this element be positioned to make sense within the context of this landscape?" For this reason, we can say that it represented an element of paramount importance in guiding the process of overcoming the limitations of tools for data visualization and for bringing the scholar within the loop of visualization.

The resulting visual artifacts are supposed to be a support for scholar's inquiry once completed. However, during their creation scholars actively engage with them, fostering the emergence of reflections, questions and eliciting their knowledge to emerge. For this reason, it is possible to say that visualization actively supported their process of critique, stimulating their work of memory and connection.

Nevertheless, they also show criticalities. This kind of visualizations require readers a lot of time to be digested, being so strongly customized and distant from ordinary visual models (e.g. bar charts or scatterplots). Some researchers pointed out that speed and efficiency better resonate with other fields of studies and that a visualization capable of slowing perception down is actually a *desiderata* in DH (Hinricks, 2018. Bradley, 2016). To compensate, it is important to pay even more attention to the formal aspects of visualization, namely titles, legends, scales, etc. In addition, such visualizations may then require to be combined with a narration, in order to better explain the richness of the embedded information and to convey authors' aims and remarks.

5. Conclusion

Within this contribution we presented the outcome of an interdisciplinary work that brought together information visualization and literary studies for the making of an interactive data visualization designed in support to literary inquiry.

Creating this visualization has been of paramount importance to align habits and fashions of the two backgrounds involved, to develop shared sensibilities and eventually to start to understand how and at which extent it is possible to combine the work of critique with the work of creation of data visualizations.

The design process of this visualization pointed towards the overcoming of limitations of tools for data visualization. Such tools rarely allow for a complete exploitation of ill-defined and inconsistent information, which is however very common in the field of DH. The design process we presented, saw a methodological integration between methods of data visualization and design, with a particular use of the visual metaphor of the natural landscape deployed in order to elicit scholars' knowledge and bring them in the loop of visualization.

Similar methodological integrations, oriented towards the exploitation of inconsistent and ill-defined information, emerge as important contributions that designers can provide to those scholars that aim to create literary critique with the support of data visualization.

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