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Conservative by design: epistemic limits in Digital Humanities visualisation practices*

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Abstract

Information visualisation is widely employed in the Digital Humanities (DH), supporting dissemination, research, and access to digital cultural collections. However, few studies survey DH visualisation practices offering in-depth discussion and qualitative insights into specific design choices, while quantitative findings are typically limited to aggregated scales (article-, project-, or interface-level analysis). This contribution builds on a previous survey of 186 DH web projects to advance the field by introducing a finer-grained perspective centred on 587 visualisation-interaction units. By analysing the interplay of visualisation and interactive choices across narrative and non-narrative contexts, we identify conservative patterns in design. Our findings suggest that DH visualisation practices prioritise simple, familiar, and convenient visualisation and interaction choices, thereby limiting diversification, interpretive richness, and effective multi-perspective disclosure of data. Similarly, narrative settings remain underexploited, frequently built on ready-made solutions, and rarely operate in symbiosis with more explorative, non-narrative views. We conclude that infrastructural constraints shape DH visualisations more than interpretive aims, advocating for future research targeting interpretive depth and visualisation designs that foreground epistemic value.

Keywords: Information Visualisation, Digital Humanities, Data Storytelling, Cultural Heritage Data, Quantitative Analysis

Le tecniche di visualizzazione dell'informazione sono ampiamente impiegate nelle Digital Humanities (DH) a supporto della disseminazione, della ricerca e dell'accesso alle collezioni culturali digitali. Tuttavia, pochi studi

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analizzano sistematicamente le pratiche di visualizzazione nelle DH, offrendo approfondimenti qualitativi su specifiche scelte progettuali, mentre i risultati quantitativi sono generalmente limitati a scale aggregate (analisi a livello di studio, progetto o interfaccia). Questo contributo si basa su una precedente analisi di 186 progetti web di DH, introducendo una prospettiva più dettagliata e centrata su 587 unità visualizzazione–interazione. Analizzando il rapporto tra le scelte progettuali di visualizzazione e di interazione in contesti narrativi e non narrativi, emergono schemi conservativi nella progettazione, suggerendo che le pratiche di visualizzazione nelle DH privilegino soluzioni visive e interattive semplici, familiari e facilmente implementabili, limitando la diversificazione, la ricchezza interpretativa e l'efficacia di prospettive multiple sui dati. Analogamente, i contesti narrativi restano poco sfruttati, spesso basati su soluzioni preconfezionate, e raramente integrati con approcci più esplorativi e non narrativi. Concludiamo che le pratiche di visualizzazione nelle DH sono modellate dai vincoli infrastrutturali più che dagli obiettivi interpretativi, evidenziando la necessità di future ricerche volte a valorizzare gli aspetti interpretativi e a promuovere progettazioni che pongano al centro la dimensione epistemica delle visualizzazioni.

Parole chiave: Visualizzazione dell'informazione, Digital Humanities, Narrazione dei dati, Dati del patrimonio culturale, Analisi quantitativa

1. Introduction[1]

Information visualisation is widely used in the Digital Humanities for a broad range of goals, including enhancing access to digital Cultural Heritage collections (Whitelaw 2015; Windhager et al. 2019), improving the dissemination of complex information, and serving as a research process in its own right (Hinrichs et al. 2019; Münster and Terras 2020). This relevance prompted a proliferation of contributions addressing the epistemic implications of visualisations and data storytelling for the Humanities from both theoretical and development-oriented perspectives (Drucker 2011; Mayr et al. 2016; van der Zwaan et al. 2016; Windhager, Salisu, and Mayr 2019; Drucker 2020; Brüggemann et al. 2020; Renda et al. 2023). A limited number of notable studies surveyed actual visualisation practices in DH (Jänicke et al. 2017; Windhager et al. 2019; Khulusi et al. 2020; Panagiotidou et al. 2023). Our previous work (Battisti and Daquino 2026) extended the scope of earlier surveys to the landscape of DH web-based dissemination projects, providing an overview of choices relating to visualisation, interaction, storytelling, and the representation of uncertainty. Although some works discuss visualisation examples and design practices in greater detail, these mainly derive quantitative conclusions at an aggregated level, leading to acknowledged limitations in the results. In particular, the interplay of visualisation techniques and interactive possibilities, and their relation to narrative and non-narrative contexts, is overlooked.

This work examines such interplay between visualisation, interaction and narrative context with higher granularity to understand how they contribute to different dissemination approaches beyond the project-aggregation level. The study provides a fine-grained account of DH visualisation practices focused on visualisation-interaction pairings (units), extends previous

[1] Tommaso Battisti is responsible for Data curation, Formal analysis, Investigation, Visualization; Marilena Daquino is responsible for Supervision, Validation; both authors are responsible for Conceptualization, Methodology, Writing – original draft, Writing – review & editing. Writing responsibilities: Tommaso Battisti (sections 2-6); Marilena Daquino (sections 1 and 7); both authors (section 8).

corpora with detailed descriptions of visualisation-interaction units in narrative and non-narrative contexts, and leads to a better understanding of research design choices.

Methodologically, the contribution adopts a quantitative perspective limited to describing formal aspects of visualisations and interactive configurations without addressing qualitative or experiential aspects of the relationship between the visualisation systems and their users, which would require a dedicated user study. Even if the identification and quantification of available features alone do not allow us to derive conclusions on the quality of a visualisation system, they make it possible to highlight emerging patterns and differences, quantify approaches and means to provide different data views, and foreground the similarity or diversity of the "palette" of available solutions (Dimara and Perin 2020).

Our findings highlight a conservative approach in DH projects, which strongly rely on non-narrative, exploratory settings using standard, simple visual and interactive solutions that are often repurposed within the same projects but rarely diversified or employed in transformative ways. While fostering reusable, open-ended solutions for engaging with heterogeneous audiences, the approach shows limitations in advancing the interpretative and epistemic affordances of data visualisation.

The remainder of the paper is structured as follows. Section 2 provides the conceptual foundations of this survey. In section 3, we discuss existing taxonomies, prior surveys, and how they inform our analysis. Section 4 presents our research questions, while Section 5 describes the materials and methods adopted. Results are presented in Section 6, followed by a discussion in Section 7, where we also acknowledge the limitations of the chosen level of granularity.

2. Definitions

Visualisation technique. In our study, visualisation techniques are computer-supported visual representations of abstract data (Card et al. 1999) that meet the following criteria: (1) being based on non-visual data; (2) generating an image from the data as the primary means to communicate them; and (3) producing a readable and recognisable result (Kosara 2007). We focus on techniques generating meaning through the interrelation of glyphs and symbols (Koponen and Hildén 2019, 32), excluding solutions such as tables (Khan and Khan 2011), lists, slideshows, grids, and mosaics (Windhager et al. 2019).

Interaction and allowable actions. Our interest lies in interactions intended as the user actions that cause visible changes in the visualisation (Yi et al. 2007; Lam 2008; Dimara and Perin 2020). In particular, we focus on the interactive possibilities of a visualisation system and borrow the term "allowable actions" (Dimara and Perin 2020) to refer to the range of interactions users can perform to modify the representation.

Visualisation-interaction unit. A visualisation-interaction unit is a distinct configuration combining a visualisation technique (or multiple techniques when linked through coordinated views) with a specific set of allowable actions (Figure 1). Following (Yi et al. 2007), we consider these elements as working interdependently to achieve a shared data-related goal. For example, if a project contains five bar charts that all support drill-down on click, they are counted as a single unit. Conversely, if the same five bar charts each offer different interactions, they are treated as separate units according to their unique visualisation-interaction combinations.

These units form the basic level of analysis in our dataset, with each row representing one unit. Units are distinguished not only by their visualisation and allowed interactions, but also by their temporal characteristics and narrative context. Temporal encodings—such as time axes, time-based animations, or other time-based variables—define a new unit even if the visualisation and interaction remain unchanged. Similarly, an identical configuration appearing in both a narrative and a non-narrative context counts as two separate units, reflecting the shift in intent and function. Accordingly, the number of units in a project does not directly correspond to the number of visualisations it contains. Two otherwise identical charts are treated as distinct units if they differ in interactive features, temporal encoding, or narrative context, while exact duplicates without variation are counted as a single unit. Every unit includes at least one visualisation technique, although interaction may or may not be present (e.g. in a static chart).

Building on the notion of visualisation-interaction units, we distinguish between two related phenomena. ***Reconfiguration*** describes the repeated use of the same visualisation technique within a project, which is recorded as multiple units when it varies by possible interactions, temporal encodings, narrative framings, or any combination thereof. Finally, within the scope of this study, a ***coordinated*** view is considered a single unit that integrates two or more distinct visualisation types, linked through interactive coordination.

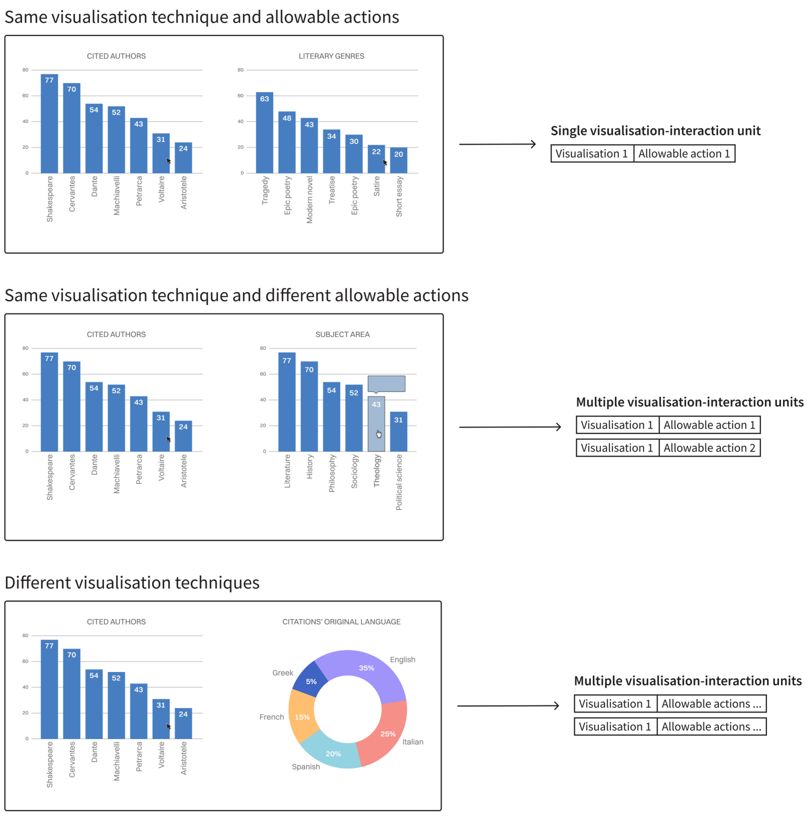

Figure 1 Example of visualisation-interaction units and how they are distinguished. Within a project, a unit is defined by the unique combination of a visualisation technique and a set of allowable actions. Two

charts using the same combination correspond to a single visualisation-interaction unit (top row). Different charts (bottom row) or charts using different allowable actions with the same technique (middle row), correspond to distinct units.

Narrativity. Storytelling entails organising pieces of evidence through rhetorical strategies (Tong et al. 2018) and drawing on both explicit and implicit knowledge (Schröder et al. 2023). A story encompasses both presented and inferred events within a narrative (Branston and Stafford 2010), incorporating facts, data, and other elements essential to the plot (Bach et al. 2018). Narrativity refers to how a story is communicated—the arrangement of its elements to construct particular perspectives (Branston and Stafford 2010). We use the term narrative to broadly encompass meaningful sequences of story pieces, often visualised and accompanied by authorial commentaries (Lee et al. 2015; Morini et al. 2025), in the form of both "author-driven" data stories (strictly organising story elements to support specific messages (Lee et al. 2015, 85) within an author-defined plot (Stolper et al. 2016)) and more "reader-driven" experiences, where users actively manipulate the narrative during exploration (Segel and Heer 2010).

3. Related work

3.1 Narrativity and interaction taxonomies

Many surveys assessed and described visualisation practices, often with the aim of defining a classification framework or descriptive taxonomy (Segel and Heer 2010; Hullman and Diakopoulos 2011; Figueiras 2013; Figueiras 2015; Stolper et al. 2016; McKenna et al. 2017; Ojo and Heravi 2018; Shi et al. 2022). Nonetheless, most of these are domain-agnostic or relate to data journalism.

Storytelling plays an important role in visualisation, serving as an aid for efficient information communication also to non-expert audiences (Kosara and Mackinlay 2013; Gershon and Page 2001; Brolcháin et al. 2017). It enhances the presentation, exploration, and interpretation of complex information also in the Cultural Heritage domain (Shan et al. 2022; Renda et al. 2023). For this reason, it is no surprise that information visualisation in narrative contexts has received specific attention. Narrative genres, visual narrative tactics, and narrative structures were first described by (Segel and Heer 2010), who drew an important distinction between author-driven and reader-driven narrative approaches, with hybrid potential in between. Further works restricted the focus to address in more depth characteristics of author-driven (Stolper et al. 2016) and award-winning data stories (Ojo and Heravi 2018), or focusing on other aspects such as rhetorical strategies (Hullman and Diakopoulos 2011), factors influencing user engagement and reading experience (McKenna et al. 2017), map-based visual storytelling design spaces (Roth 2021), or narrative aspects related to media and communication methods (Zhao and Elmqvist 2023).

Interaction is another significant aid for visualisation, shaping the readers' experience and connecting story components in narrative contexts (Segel and Heer 2010; Ojo and Heravi 2018), while supporting visual exploration in non-narrative settings (Keim 2002), and potentially acting as a bridge between exploration and narration (Morini et al. 2025). After Shneiderman's "Visual Information Seeking Mantra"—overview first, zoom and filter, then details-on-demand—(Shneiderman 1996), alternative browsing models were proposed (Van Ham and Perer 2009), along with several interaction taxonomies (Keim 2002; Ward and Yang 2004; Yi et al. 2007; Heer and Shneiderman 2012; Figueiras 2013; Figueiras 2015). However, these taxonomies were recognised to differ in both scope and abstraction, ranging from low-level interaction techniques to high-level tasks and user goals (Yi et al. 2007; Morini et al. 2025). To address this, (Yi et al. 2007) grouped low-level interaction techniques into high-level categories based on the concept of user intent, while (Munzner 2009) situates tasks and interactions within a nested model useful for design and evaluation. (Dimara and Perin 2020) propose an intent-agnostic definition of interaction relying on actions users are allowed to perform, distinguishing: (1) data actions, involving operations on intangible data; (2) perceptualisation data actions, affecting data presentation; and (3) non-data actions, unrelated to data or its presentation. Another modular, multi-level typology uses three key questions—why, how, and what—to describe complex tasks denoting their purpose, method, and subject (Brehmer and Munzner 2013; Munzner and Maguire 2015).

In the present work, we do not revisit the deeper narrative aspects already analysed in our previous work at a project level, to focus on the use of a visualisation-interaction unit within a narrative or non-narrative context. By acknowledging the interdependency between the representational and interactive components in visualisation systems, we relate to the concept of "allowable actions" (Dimara and Perin 2020) and the manipulative and encoding subsets of Brehmer and Munzner's typology (Brehmer and Munzner 2013), and we reuse and adapt user intent categories identified by (Yi et al. 2007) for our classification.

3.2 Surveys in the DH

Overall, only a few surveys describe information visualisation practices in the DH. These mainly restrict the focus to specific sub-domains and limited scopes, such as text analysis tasks and visualisation techniques supporting close and distant reading (Jänicke et al. 2017), visualisations for particular research inquiries and tasks in musicology (Khulusi et al. 2020), and uncertainty representation methods in DH research using visualisations (Panagiotidou et al. 2023). A broader perspective is adopted by Windhager et al., who survey Cultural Heritage collection interfaces, covering data types, target users, tasks, visualisations, visual granularity, and interactions (Windhager et al. 2019). They also identify curated paths: browsing modalities either generated by interface providers by means of narrative information design, or by visitors' exploration through interaction behaviour (Windhager et al. 2019, 2317). This distinction encompasses both author-driven and reader-driven narrative approaches (Segel and Heer 2010).

Moreover, in our previous work we contributed to the field by further extending both the scope and the domain of inquiry in a dataset (Battisti 2024), an analysis notebook (Battisti 2025a), and a related article (Battisti and Daquino 2026) reviewing the use of information visualisation, narrativity and narrative design strategies, interactive solutions, humanities domains, critical approaches to humanities visualisations, and uncertainty representation methods in web-based DH projects. Nonetheless, a significant limitation of surveys focusing on projects or interfaces as aggregated entities—including multiple sections, objectives, visualisations, and related characteristics—is that they inevitably obscure more specific information at the visualisation-interaction level. For example, in our earlier work, conclusions about the co-occurrence of different visualisation techniques do not distinguish whether those techniques were combined in the same coordinated view or instead used separately in different sections of the same website. Similarly, it was also not possible to distinguish in which narrative context a specific visualisation-interaction unit appeared within projects that included both narrative and non-narrative sections. Even conclusions involving the relationship between visualisation techniques and allowable interactions remain limited due to the inevitable loss of the link between the two during the aggregation of the observations at the project level.

This study builds on our previous work, aiming to deepen its focus and reveal more nuanced insights from a corpus of visualisation-interaction units. We emphasise the interdependence between the visual representation and the interactive layers of a visual system, treating their relationship as a meaningful unit of analysis. Drawing on both the classification schema developed in our earlier study and the same corpus of projects, we classify each unit by its narrative context, visualisation techniques, and allowable actions—while also noting which visualisation technique serves as the primary one when analysing instances combined in coordinated views. This approach addresses limitations posed by the presence of multiple visualisations within the same project and extends our earlier contribution by offering a more comprehensive perspective on the use of visualisation and interactive solutions in web-based DH projects.

4. Methodology and research questions

We survey 186 DH web-based projects that employ information visualisation techniques and adapt existing taxonomies to classify a total of 587 visualisation-interaction units. The classification is performed through an empirical evaluation and relies on a schema similar to that used in our prior work (Battisti and Daquino 2026), thereby enabling cross-checking opportunities.

In light of the conclusions of the previous study, we refine our analysis to better frame design decisions concerning visualisation and interactivity in DH web-based projects. The study is guided by two assumptions framing the research questions:

Assumption 1. *Recurring design patterns in dissemination artefacts encode interpretable scholarly approaches.* Recurrence in design choices and adopted solutions across different examples reflects established frameworks and approaches. Without measuring user comprehension, a systematic analysis of a large and diverse corpus of projects can, therefore, provide empirical evidence of the design logics governing DH dissemination.

RQ1. *How do visualisation and interaction practices vary in complexity and configuration across DH projects, and what do they reveal about scholarly practices?*

This study investigates several key aspects of how projects are structured and how visualisation-interaction units are used within them. First, we examine the number of units each project contains to quantify its overall structural complexity. We then explore which visualisation types appear most frequently, which tend to recur across multiple configurations within the same project, and what such variations reveal about their interpretive affordances. We also analyse visualisation changes by identifying how many projects include interactions that provoke a change between visualisation types or variants of the same visualisation, which visualisations are most often involved, and whether these changes are accompanied by other substantial interaction shifts. Further, we consider interaction patterns and their degree of standardisation by assessing which allowable actions are most popular across projects and units, and whether they are shared across different visualisation types or confined to specific ones—thereby indicating tendencies toward either standardisation or customisation. Finally, we investigate coordination by looking at how many projects employ coordinated views, which visualisation techniques typically hold a central role within them, which are most often used in combination, and whether their connections rely on brushing and linking or on other forms of coordination.

Assumption 2. *Narrative and non-narrative contexts are associated with different design choices* (Battisti and Daquino 2025). Hybrid projects identify cases where narration and open-ended exploration are both employed to provide a diversified dissemination experience. Analysing visualisation and interaction choices at the level of visualisation-interaction units enables the identification of emerging patterns or uneven uses of visual and interactive solutions across different narrative contexts, which would remain invisible at an aggregated level.

RQ2. *What approaches are typical in DH visualisation, and how different design decisions in visualisation and interaction relate to different narrative contexts?*

This study examines project composition by analysing how many visualisation-interaction units typically appear within narrative, non-narrative, and hybrid project contexts, as well as the balance of narrative and non-narrative components within hybrid projects. It further explores visualisation and interaction patterns, investigating how units differ between narrative and non-narrative contexts. Lastly, it considers visualisation changes and coordinated views, asking whether narrative or non-narrative contexts influence changes in visualisation type or between variants of the same visualisation, whether narrative context affects the presence of coordinated views, and how the choice of main visualisation relates to narrative context.

5. Materials and methods

5.1 Corpus building

Our corpus of visualisation-interaction units is derived from the corpus of DH projects (Battisti 2024). Accordingly, visualisation-interaction units come from projects that: (1) are web-based dissemination projects, (2) produce visualisations through tools or software, (3) are free from access barriers, (4) significantly rely on visualisation, and (5) were accessible at the time of assessment. As for the sources, the corpus draws on that of (Windhager et al. 2019), which provided us with a list of practitioners (designers, developers, and researchers) whose websites were later reviewed to identify additional material (14 + 19 projects). We also included projects mentioned on the websites of the Italian (AIUCD)[2] and European (EADH)[3] DH associations (12 + 92 projects). Finally, the "Best DH data visualisation" category of the Digital Humanities Awards website[4] provided an additional 49 projects. Only visualisations that fall within our definition of visualisation technique (see Section 2) were considered for the analysis, for a total of 587 visualisation-interaction units. The final dataset (Battisti 2025b) was analysed in a Jupyter Notebook (Battisti 2025c) to ensure reproducibility.

5.2 Classification: methods and schema

We reuse the classification schema developed in our prior work (Battisti and Daquino 2026), which was built through an iterative approach inspired by (Segel and Heer 2010), progressively

[2] Associazione per l'Informatica Umanistica e la Cultura Digitale (AIUCD), https://www.aiucd.it/progetti/.

[3] European Association for Digital Humanities (EADH), https://eadh.org/projects.

[4] http://dhawards.org/.

refining it while evaluating a project sample. Each revision of the schema was re-applied to the sample and eventually to the full corpus to ensure consistency.

Each unit was evaluated empirically through direct observation and interaction with the visualisation system, rather than relying on descriptive documentation. The final schema was tested by two annotators, who reviewed a subset of instances to assess consistency. To further validate the approach, the project-level dataset and the visualisation-interaction unit dataset were compiled at different times. The visualisation-interaction unit dataset was then aggregated by project and compared against the project-level dataset using Python, confirming a one-to-one alignment. We acknowledge the inevitable presence of subjectivity when imposing a custom taxonomy across different design dimensions (Segel and Heer 2010, 1145). This limitation is intrinsic to the method we used but mitigated through iterative refinement and cross-checking between levels of analysis.

The schema addresses the following categories and values, with a more specific focus on visualisation techniques and allowable actions:

Visualisation techniques. Adapted from (Windhager et al. 2019), a set of columns (with Boolean values) identify the presence of the following visualisation types, including stacked or other kinds of variants: (1) *plot*; (2) *cluster or set*; (3) *map*, also reporting the additional visualisation used in statistical symbol maps (i.e. maps where data points are statistical charts); (4) *network*; (5) *hierarchical diagram*; (6) *treemap*; (7) *word cloud*; (8) *bars*, for any bar-based chart including histograms; (9) *line chart*; (10) *area chart*; (11) *pie chart*; (12) *3D plot*; (13) *proportional area*; (14) *timeline*; (15) *other*, miscellaneous. In addition, the group of techniques to encode temporality is included and adapted: (1) *temporal dimension*, time is mapped to any dimension of a visualisation except for timelines; (2) *animation*; (3) *visual variable*, other visual encoding strategies (e.g. colour).

Primary visualisation. A column is added to assess which visualisation type—if any—can be considered central or more important than others in the case of coordinated views. The column is empty in case the visualisations have the same or similar importance.

Allowable actions. As in the previous work, due to the empirical approach, we do not rely on abstract tasks, since it is argued that although important to the design of visualisation instruments, users typically rely on intuition, ignoring predefined sequences and operations (Andrienko and Andrienko 2006). Therefore, a set of columns distinguishes the presence of the following interaction capabilities, related to the concept of user-intent (Yi et al. 2007), user-allowed data actions (Dimara and Perin 2020), and the manipulative subset of methods by (Brehmer and Munzner 2013). Differently from the project-level work (using Boolean values only), for each category, we specify the particular action involved: (1) *basic selection*, the demarcation of an element either for the duration of the interaction (*highlight*) or more permanently until the occurrence of another selection (*mark*); (2) *advanced selection*, the demarcation of an element triggers the demarcation of related instances within the same visualisation (*connect*) or leads to a *brush and link* effect across views (e.g. selecting a subset of datapoints in a plot automatically highlights the corresponding items in other coordinated views, such as a map). Basic selection is tacitly implied; (3) *navigation*, *move* interactions performed by zooming, panning, rotating, and scrolling but only when applied to the visualisation and not to the web page; *drill* interactions to navigate through different levels or portions of data detail, often generating a new view that replaces or accompanies the original (e.g. clicking on a bar that represents a specific category within a bar chart opens a more detailed visualisation showing the individual records composing that bar); and *expand* interactions generating new perspectives on data by expanding and collapsing nodes; (4) *arrangement*, methods to organise visualisation elements (symbols, glyphs, etc.) or multi-visualisation layouts spatially, either one by one e.g. via drag and drop (*manual*) or involving all elements at once by means of criteria-based triggers (*automatic*); (5) *change*, alteration of visual encoding involving the visualisation as a whole. A change can involve a shift in visualisation type (e.g. a bar chart transforming into a pie chart), a transition between visualisation-variants within the same type (e.g. an area chart transitioning into a stacked area chart), any *attribute* like glyph colour, size, shape, etc., or axes inversion and scale modifications, and *other* possible changes;[5] (6) *visualisation filter*, to seamlessly exclude or include existing visualisation elements with respect to *spatial*, *temporal*, or *other* criteria, without reloading or generating a new visualisation; (7) *collection filter*, visualisation elements act as a filter for a related collection or list of items (e.g. lists of items filtered by clicking on a map region). They can be related to *spatial*, *temporal*, or *other* dimensions; and (8) *aggregation*, which mutates the granularity of visual elements according to spatial, temporal, or other types of variables, producing either visual data summarisation or segregation into smaller instances.

Narrativity. Two columns—(1) *narrative*, and (2) *non-narrative*—identify whether the visualisation-interaction units are used within a narrative. A unit is classified as "narrative" when it takes part in a cohesive communicative structure, interacting with surrounding—typically textual—elements to form a narrative argument.

6. Results

6.1 RQ1. Complexity and configurations of visualisation-interaction practices across DH projects

Quantifying projects' structure. Most DH projects are structurally simple, typically using only a small number of visualisation-interaction units. 93% of projects (173/186) contain between one and six units, with projects containing a single unit being most common (42.5%, 79/186) and those with two or three units next (27.4%, 51/186) (Figure 2). Only a few outliers use far more (up to 16, 17, 21, or even 24 units).

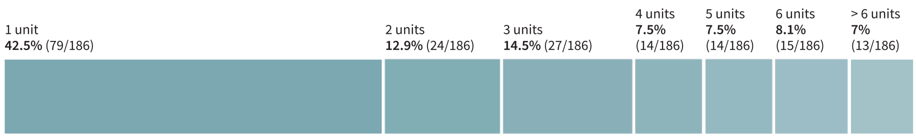

Figure 2 Distribution of projects by number of visualisation-interaction units (n = 186).

About a third of projects reuse the same visualisations in reconfigured forms (31.7%, 59/186), accounting for 38.7% of all analysed units (227/587). In most of these projects, reconfigurations involve two to four units (79.7%, 47/59), though a few cases reach as many as 16 units (Figure 3).

[5] When the visualisation type of a unit interactively transforms into another type, the dataset records each resulting version as an additional row, using both the original unit identifier (to group the different versions belonging together) and an additional version identifier. Each row therefore includes three identifiers: one referring to the project, one identifying the unit number (resetting from 1 within each project), and one specifying the version number for units whose visualisation type changes due to interaction.

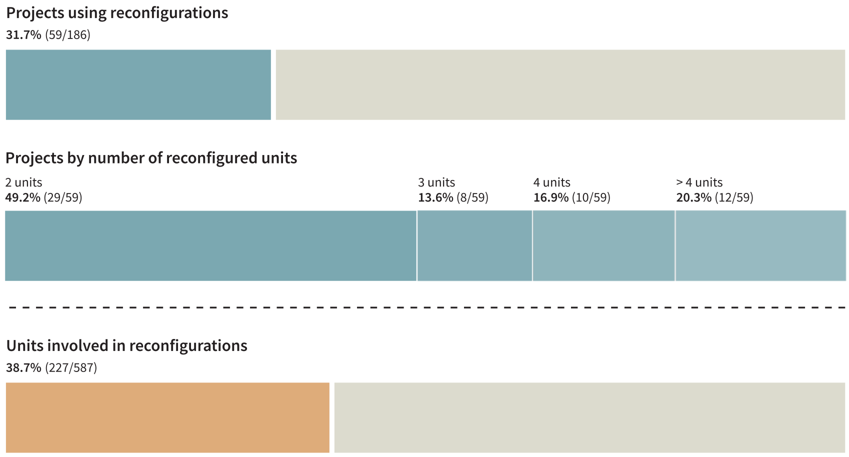

Figure 3 Projects using reconfigurations (top; n = 186); distribution of projects using reconfigurations by number of reconfigured units (middle; n = 59); and visualisation-interaction units involved in reconfigurations (bottom; n = 587).

Frequency and recurring types. Two visualisation types—maps and bar-based charts—appear far more often than any others and are also the most frequently repurposed. Maps account for 36.6% (215/587) and bar-based charts for 20.4% (120/587) of all units. Networks (10.6%, 62/587) and other types are much rarer (Figure 4).

Reconfiguration is especially frequent in units with maps (45.1%, 97/215), plots (47.5%, 19/40), bar-based charts (44.2%, 53/120), and networks (37.1%, 23/62). Most other types are reconfigured less than 20% of the time (Figure 4). Projects that reuse visualisations usually show only up to two additional configurations of the same chart (e.g. maps average 1.81 configurations; bar charts 1.38).

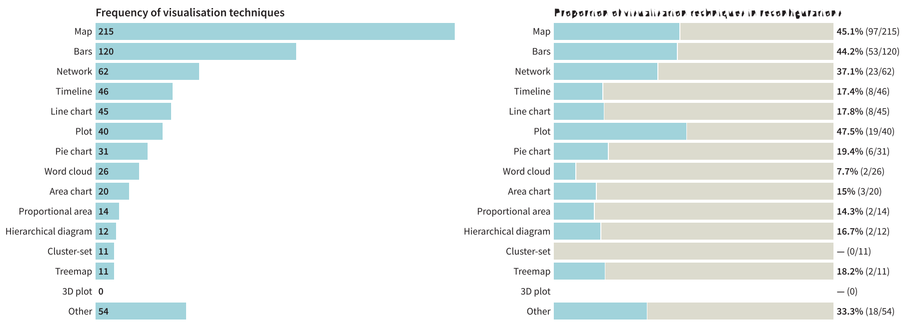

Figure 4 Frequency of visualisation techniques across units (n = 587) (left) and their proportion in reconfigured versus non-reconfigured units (right).

Differences between reconfigured units are driven mainly by interaction changes rather than narrative or temporal shifts. Across all projects, 212 pairs of reconfigured units were identified.

In 90.1% (191/212), differences in allowable actions are present, often being the only variant (59.9%, 127/212) (Figure 5). Changes involving exclusively temporal aspects (7.1%, 15/212) or narrativity (2.4%, 5/212) are rare. Mixed differences occur in 15.1% (interaction + temporal; 32/212) and 13.7% (interaction + narrative; 29/212) of pairs.

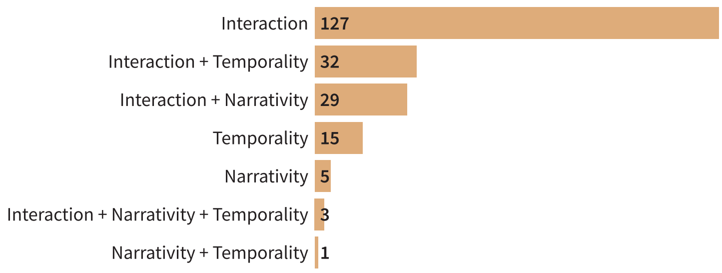

Figure 5 Distribution of differences across reconfiguration unit pairs (n = 212).

Beyond interaction alone, pairs of reconfigured map-based units frequently exhibit multifactor differences, particularly in the combination of interaction and narrativity (24.2%, 24/99) (Table 1). Bar-based charts also show notable multifactor changes, primarily involving allowable actions and temporal encoding (31.6%, 12/38). In contrast, network pairs (86.7%, 13/15) and plot-based pairs (80%, 12/15) almost always differ in allowable actions alone.

Unit composition (visualisation techniques)	**Interaction**	**Temporality**	**Narrativity**	**Int. + Temp.**	**Int. + Narr.**	**Narr. + Temp.**	**Int. + Narr. + Temp.**
Map	**60**	**2**	**3**	**8**	**24**	0	**2**
Bars	**20**	**6**	0	**12**	0	0	0
Network	**13**	0	0	**2**	0	0	0
Plot	**12**	**3**	0	0	0	0	0
Timeline	**3**	0	0	0	**1**	0	0
Pie chart	**3**	0	0	0	0	0	0
Line chart	**2**	0	**1**	**2**	**1**	**1**	**1**
Area chart	**1**	**1**	0	**1**	0	0	0
Word cloud	**1**	0	0	0	0	0	0
Proportional area	**1**	0	0	0	0	0	0
Treemap	**1**	0	0	0	0	0	0

Hierarchical diagram	**1**	0	0	0	0	0	0
Network + Bars	**1**	0	0	0	0	0	0
Map + Bars	0	**1**	0	**1**	**1**	0	0
Plot + Bars	**1**	0	0	0	0	0	0
Map + Network + Timeline	0	0	**1**	0	0	0	0
Plot + Map + Bars + Timeline	**1**	0	0	0	0	0	0
Other	**6**	**2**	0	**6**	**2**	0	0

Table 1 Factors of difference across reconfigured unit pairs by visualisation type composition (n = 212).

Changes involving interaction typically encompass between one and six allowable actions (mean = 2.5). Highlighting (42.4%, 81/191), attribute-based filters (34.6%, 66/191), and mark selection (30.4%, 58/191) are the most frequent (Figure 6). Other allowable actions contribute to differences in less than 20% of pairs, with only move, spatial aggregation, and temporal visualisation filter interactions ranging between 15% and 20%. Broader categories of interaction changes follow this pattern: basic selection (56.5%, 108/191), filters (45%, 86/191), and navigation (33.5%, 64/191) dominate. While aggregation and change interactions both account for 27.2% (52/191), other groups follow with less than 15% each.

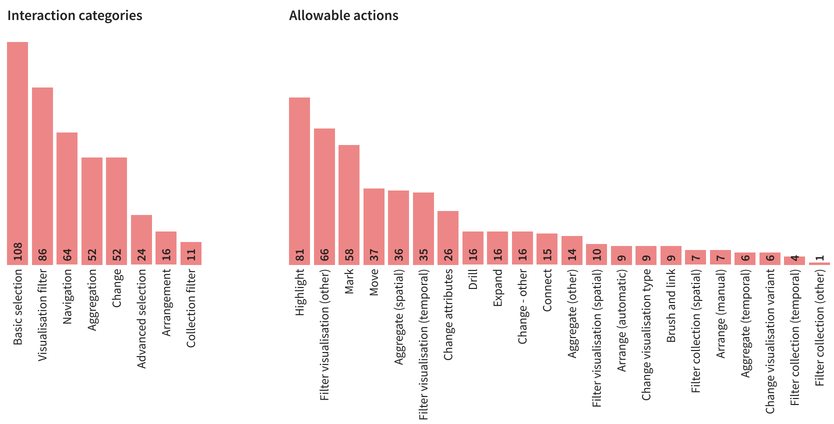

Figure 6 Distribution of interaction differences across the reconfigured unit pairs where interactions determine variation (n = 191), shown by broader categories (left) and specific allowable actions (right).

Visualisation change. Changing visualisation type (here called transformations) or visualisation variant interactively happens in only a small minority of projects. Only 10.8% of projects (20/186) use visualisation transformations, involving 8.6% of units (50/587) (Figure 7). These comprise 21 distinct combinations, usually small in scale (mean = 2.38; median = 2 units), with one project standing out by including both a four-unit and a two-unit transformation. Over half of the cases (52.4%, 11/21) involve coordinated multi-type views transforming into another coordinated view. The remaining transformations involve single visualisation types (23.8%, 5/21) and mixed cases combining single and coordinated views (23.8%, 5/21) (Figure 8).

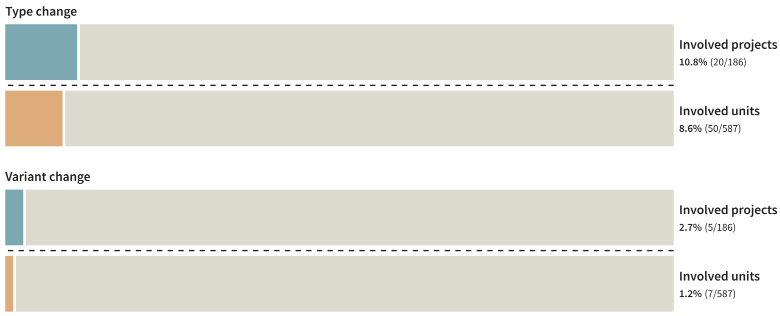

Figure 7 Visualisation type transformations (top) and visualisation-variant changes (bottom) across projects (n = 186) and units (n = 587).

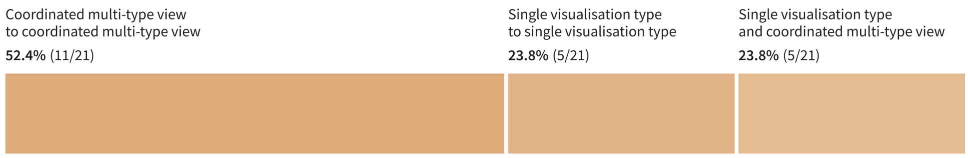

Figure 8 Composition of visualisation type transformations, distinguishing cases involving coordinated views only, single-type units only, and mixed cases (n = 21).

Even rarer are changes involving visualisation variants, which occur in only 2.7% of projects (5/186) and affect 1.2% of units (7/587) (Figure 7). All affected units involve bar-based charts, sometimes alongside line charts (3), word clouds (3), or area charts (1) (Figure 9).

Figure 9 Visualisation techniques affected by visualisation-variant changes (n = 7).

Interaction patterns and standardisation. Interaction repertoires are narrow, dominated by simple solutions, while complex interactions remain rare. Basic selection (72.9%, 428/587), navigation (54.2%; 318/587), and visualisation filters (38.8%, 228/587) are the most common across units. Less frequent interaction categories include change (18.6%, 109/587), advanced selection (15.7%, 92/587), aggregation (10.1%, 59/587), collection filters (9.4%, 55/587), and arrangement (8.0%, 47/587). Notably, one-fifth of units have no interaction at all (20.1%, 118/587) (Figure 10).

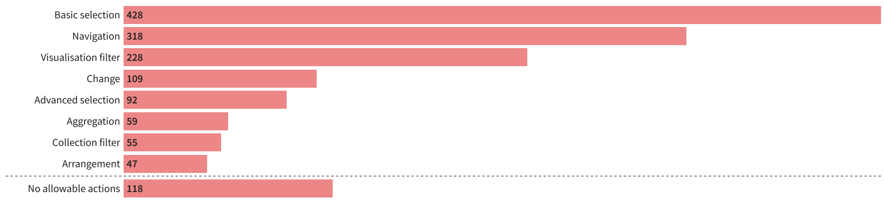

Figure 10 Frequency of interaction categories across all visualisation-interaction units (n = 587).

At the level of specific actions, simple actions like highlighting (56.7%, 333/587), moving (49.7%, 292/587), and marking (40.4%, 237/587) are the most prevalent. Other visualisation filters (34.6%, 203/587) and temporal visualisation filters (18.9%, 111/587) are less frequent, while other advanced methods (relational, exploratory, drill, brush and link, etc.) each appear in fewer than 10% of units (Figure 11).

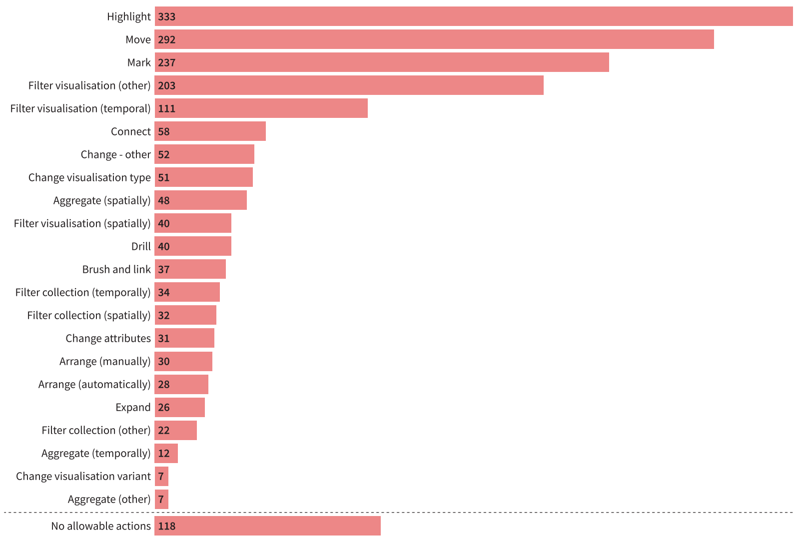

Figure 11 Frequency of allowable actions across all visualisation-interaction units (n = 587).

Co-occurrence patterns reflect this simplicity: static units are most common, followed by basic selection + navigation (12.1%, 71/587), basic selection alone (10.4%, 61/587), and basic selection + navigation + visualisation filters (9.7%, 57/587). Together with static units, these cases account for more than half of all units (52.3%, 307/587) (Figure 12).

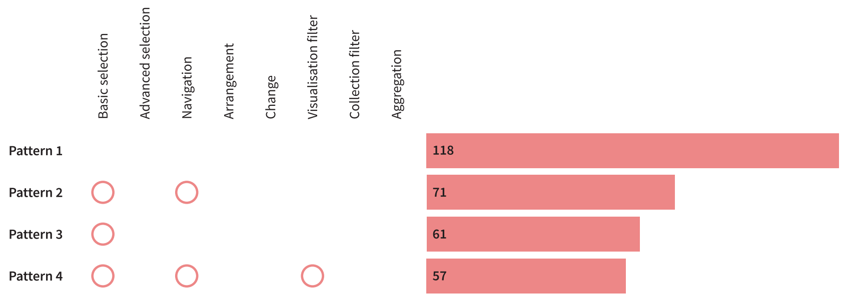

Figure 12 The four most frequent interaction patterns across visualisation-interaction units (n = 587).

While most visualisation types rely on the same basic techniques, a few techniques show slight differences. Maps, networks, timelines, and cluster/set visualisations frequently use basic selection and navigation actions (Figure 13). Only networks use advanced selection regularly, while hierarchical diagrams rely mostly on navigation. Visualisation filters appear mainly in cluster/set visualisations and occasionally in maps. Even within types, simple actions (highlight, mark, move, basic filters) dominate over more complex or specialised ones (Figure 14).

Figure 13 Co-occurrence of visualisation techniques and interaction categories, showing the proportion of each technique employing a given interaction. Values are row-normalised by the total frequency of

each visualisation type in single-visualisation units (n = 492), with types on the y-axis ordered by absolute frequency from highest to lowest.

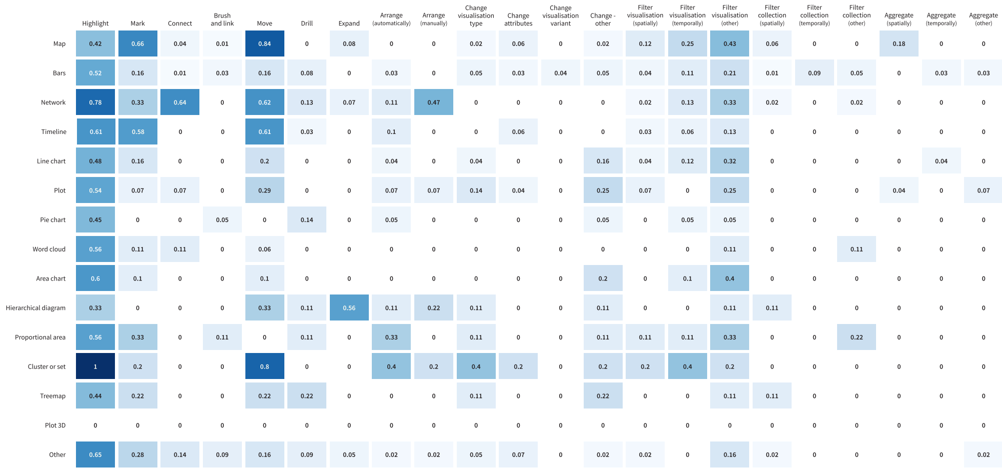

Figure 14 Co-occurrence of visualisation techniques and allowable actions, showing the proportion of each visualisation technique employing a given action. Values are row-normalised by the total frequency of each visualisation type in single-visualisation units (n = 492), with types on the y-axis ordered by absolute frequency from highest to lowest.

Coordination. Coordinated views linking multiple visualisation techniques appear in less than a third of projects (28.5%, 53/186), involving 16.2% of units (95/587) (Figure 15). Most contain just two visualisation types (78.9%, 75/95) (Figure 16) and often centre on maps (54.7%, 52/95). Bar-based charts are also relatively frequent in this context (47.4%, 45/95), followed by line charts (21.1%, 20/95), networks (17.9%, 17/95), and timelines (15.8%, 15/95) (Figure 17).

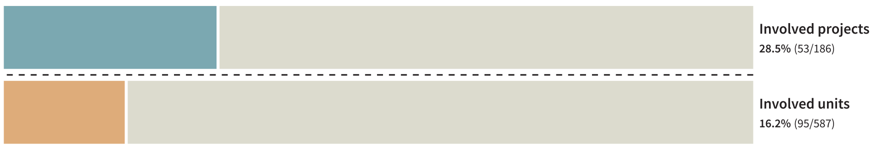

Figure 15 Coordinated views across projects (n = 186) and units (n = 587).

Figure 16 Composition of coordinated views by number of different visualisation techniques involved (n = 95).

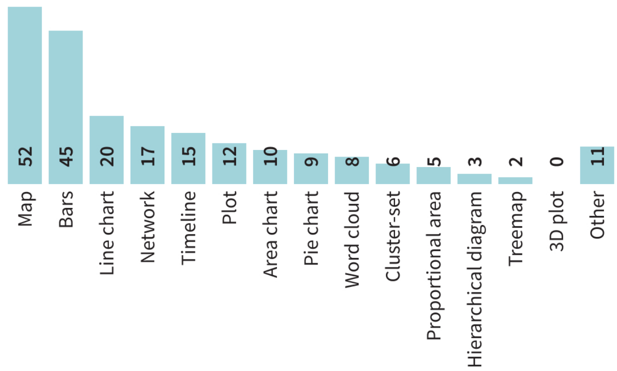

Figure 17 Frequency of visualisation techniques in coordinated views (n = 95).

Common pairs are maps + bar-based charts (17.9%, 17/95), maps + line charts (11.6%, 11/95), and maps + timelines (6.3%, 6/95), bar-based charts + timelines (5.3%, 5/95), and networks + bar-based charts (4.2%, 4/95), which together make up nearly half of all coordinated units (45.3%, 43/95) (Figure 18).

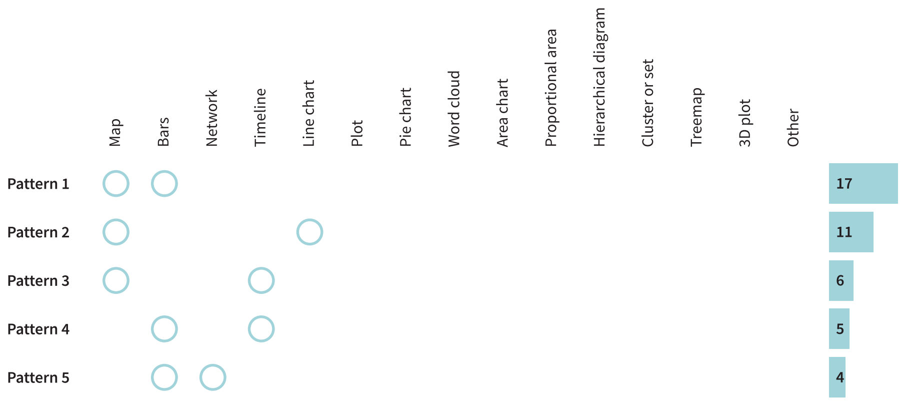

Figure 18 Most frequent pairs of visualisation techniques in coordinated views (n = 95).

Figure 19 Coordinated views with a dominant visualisation technique (n = 95).

Usually, one visualisation type is dominant (80%, 76/95) (Figure 19), especially maps (44 times; 84.6% when present) (Figure 20). Brushing and linking is only relatively frequent in this context (29.5%, 28/95) but occurs more often here than in single-visualisation units, alongside other interactive options (visualisation type/variant changes, collection filters, temporal aggregation) (Figure 21).

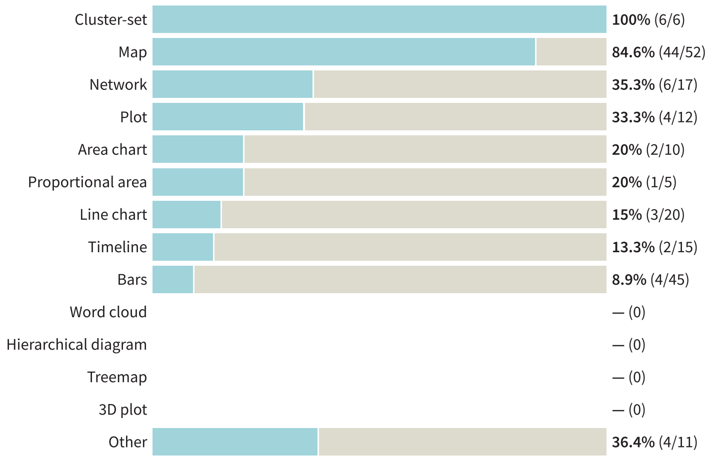

Figure 20 Proportion of times each visualisation technique is dominant, relative to its total occurrences in coordinated views.

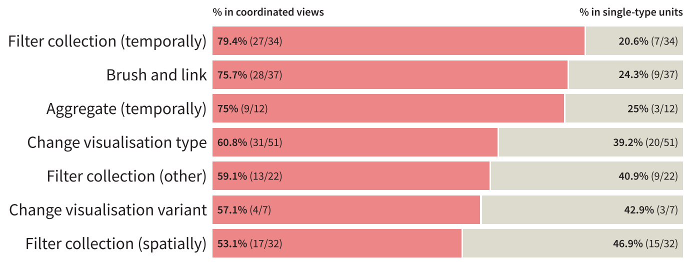

Figure 21 Proportion of allowable actions that occur more often in multi-type coordinated units, split by their frequency in coordinated views versus single-type units.

6.2 RQ2. Narrativity in relation to visualisation and interactive choices

Project composition. Narrative projects are smaller and simpler, while non-narrative and hybrid projects use more visualisation-interaction units. Narrative projects (n = 19) contain between one and six units, most often one (mean = 2.2; median = 1). Non-narrative projects (n = 143) range from one to 21 (mean = 2.7; median = 2), with more outliers (Figure 22).

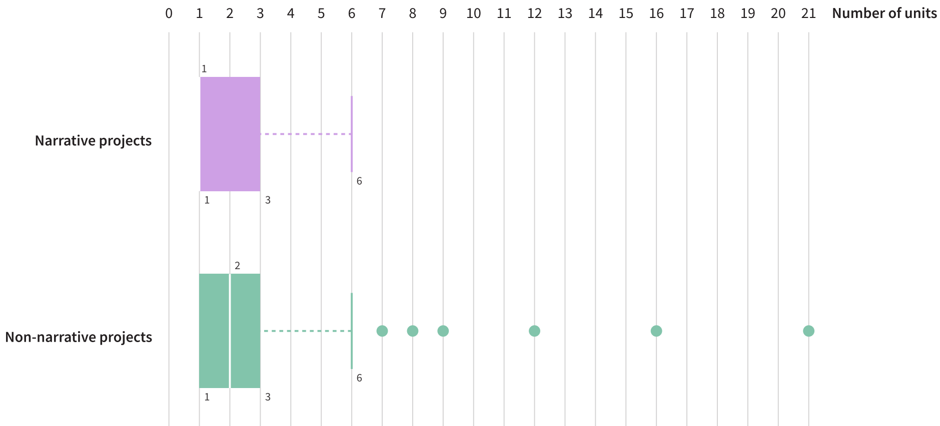

Figure 22 Number of visualisation-interaction units in narrative (n = 19) and non-narrative (n = 143) projects.

Hybrid projects (n = 24) typically employ more non-narrative units (54.2%, 13/24), though 25% favour narrative ones (6/24) and 20.8% balance both (5/24) (Figure 23). On average, hybrids host more units (3.1 narrative; 3.3 non-narrative), but this is skewed by two extreme cases (16 and 23 units in narrative contexts) (Figure 24). The most common number remains a single unit for both narrative (mode = 1; median = 1) and non-narrative (mode = 1; median = 3) contexts.

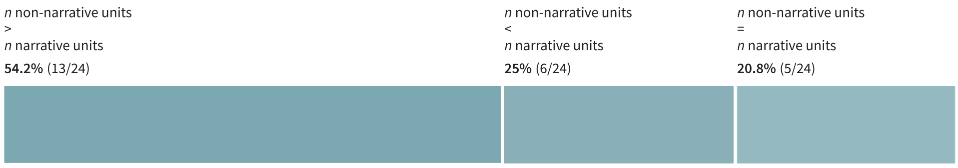

Figure 23 Proportion of hybrid projects (n = 24) with more, fewer, or an equal number of non-narrative versus narrative visualisation-interaction units.

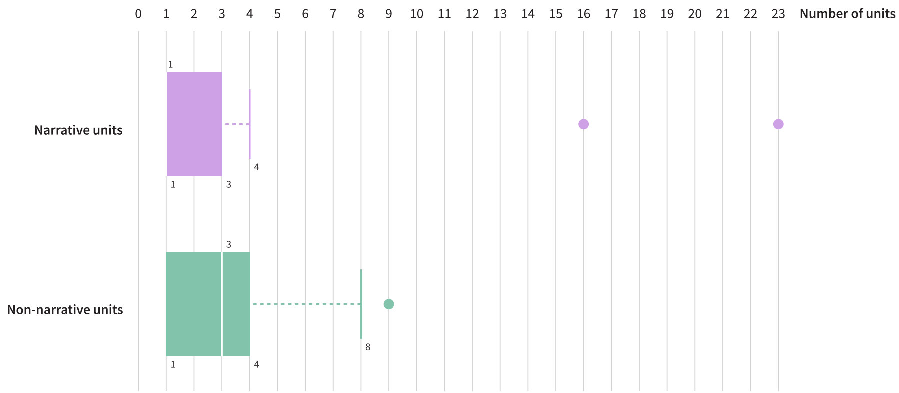

Figure 24 Number of narrative and non-narrative visualisation-interaction units in hybrid projects (n = 24).

Visualisation and interaction patterns. Most visualisation-interaction units appear in non-narrative contexts, which show a broader variety of visualisation types. Non-narrative contexts contain 80.2% of all units (471/587), while narrative contexts hold 19.8% (116/587) (Figure 25).

Figure 25 Proportion of non-narrative and narrative visualisation-interaction units across the dataset (n = 587).

Maps appear most frequently and with similar proportions in both non-narrative (37.2%, 175/471) and narrative (34.5%, 40/116) units, as do bar-based charts (21%, 99/471 vs. 18.1%, 21/116) (Figure 26). Networks show the steepest decline, being the most frequent technique to drop markedly from non-narrative (12.1%, 57/471) to narrative (4.3%, 5/116) context. In contrast, plots increase from 5.1% (24/471) in non-narrative to 13.8% (16/116) in narrative context, as do timelines (7.2%, 34/471 vs. 10.3%, 12/116). Cluster and set visualisations are the only type slightly more common in narrative units also in absolute terms (5/471 vs. 6/116) (Figure 26).

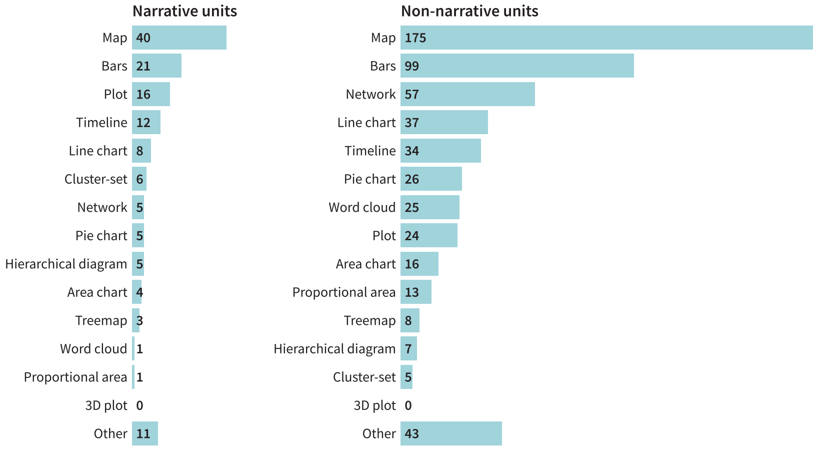

Figure 26 Frequency of visualisation techniques in narrative (left; n = 471) and non-narrative (right; n = 116) visualisation-interaction units.

Non-narrative units feature richer interaction repertoires, while narrative ones allow fewer and simpler interactions. Non-narrative units allow 0–11 actions (mean = 3.2; median = 3); narrative units enable 0–10 (mean = 2.1; median = 2) (Figure 27). Filters drop sharply in narrative settings: visualisation filters from 42.9% (202/471) to 22.4% (26/116); collection filters disappear entirely. Arrangement interactions also drop from 9.1% (43/471) to 3.5% (4/116) (Figure 28). In relative terms, there are more static narrative units (31%, 36/116) than static non-narrative ones (17.4%, 82/471) (Figure 28).

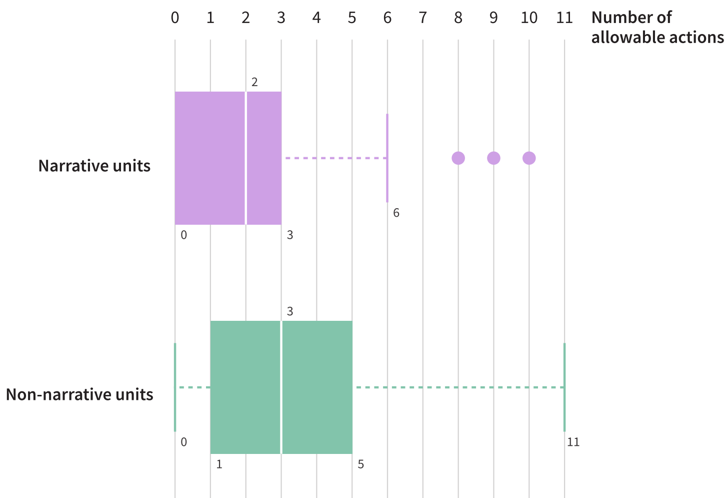

Figure 27 Number of allowable actions in narrative (n = 116) and non-narrative (n = 471) visualisation-interaction units.

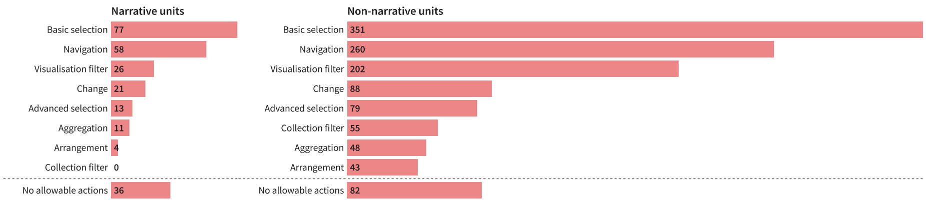

Figure 28 Frequency of interaction categories in narrative (left; n = 116) and non-narrative (right; n = 471) visualisation-interaction units.

Highlight, move, and mark remain the most common actions in both contexts, although they are less prevalent in narrative units (49.1%, 57/116; 46.6%, 54/116; and 31%, 36/116) compared with non-narrative ones (58.6%, 276/471; 50.5%, 238/471; and 42.7%, 201/471). Similarly, more exploratory interactions—such as drilling (3.5%, 4/116 vs. 7.6%, 36/471), brushing and linking (3.5%, 4/116 vs. 7%, 33/471), connecting (8.6%, 10/116 vs. 10.2%, 48/471), and expanding (3.5%, 4/116 vs. 4.7%, 22/471)—are less frequently employed in narrative contexts (Figure 29). In contrast, some change interactions appear more often in narrative units: changing attributes (7.8%, 9/116 vs. 4.7%, 22/471), changing visualisation variant (2.6%, 3/116 vs. 0.9%, 4/471), while other visualisation changes are similarly frequent (8.6%, 10/116 vs. 8.9%, 42/471). Temporal/spatial aggregations decline in narrative units, but other types of aggregation rise (4.3%, 5/116 vs. 0.4%, 2/471) (Figure 29).

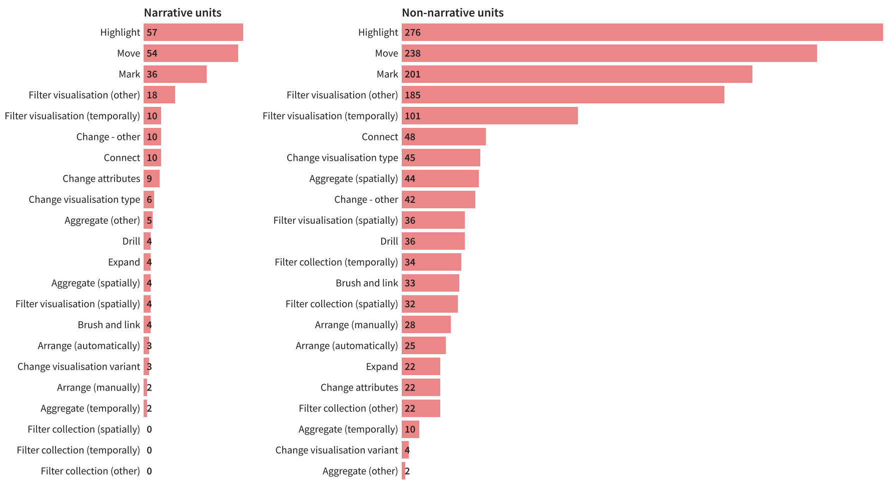

Figure 29 Frequency of allowable actions in narrative (left; n = 116) and non-narrative (right; n = 471) visualisation-interaction units.

Visualisation changes and coordinated views. Both narrative and non-narrative projects rarely change visualisation type or variant, and when they do, only a few projects are involved. Visualisation-variant changes appear in 2.6% of narrative (3/116) and 0.9% of non-narrative (4/471) units; type changes involve 5.2% of narrative (6/116) and 9.6% of non-narrative (45/471) units (Figure 30). All visualisation-variant and type changes in narrative contexts come from a single project. In non-narrative settings, four projects use visualisation-variant changes (one each), and 19 projects use type changes (an average of 2.3 each) (Figure 31).

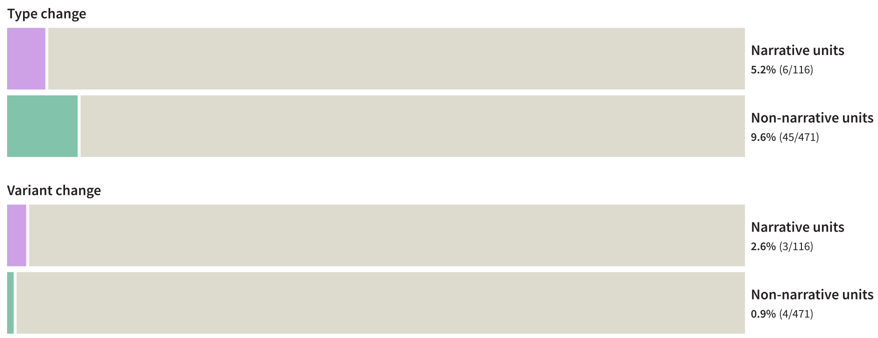

Figure 30 Visualisation type transformations (top) and visualisation-variant changes (bottom) across narrative and non-narrative visualisation-interaction units.

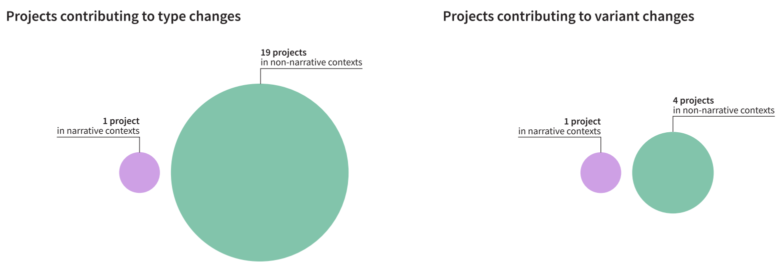

Figure 31 Projects employing visualisation-variant changes (left) and type changes (right) in narrative and non-narrative settings.

Coordinated multi-type views appear more often in non-narrative contexts, while narrative ones feature different visualisation mixes. Coordinated views occur in 12.9% of narrative units (15/116; 7 projects) and 17% of non-narrative units (80/471; 49 projects). Three projects use them in both contexts (Figure 32).

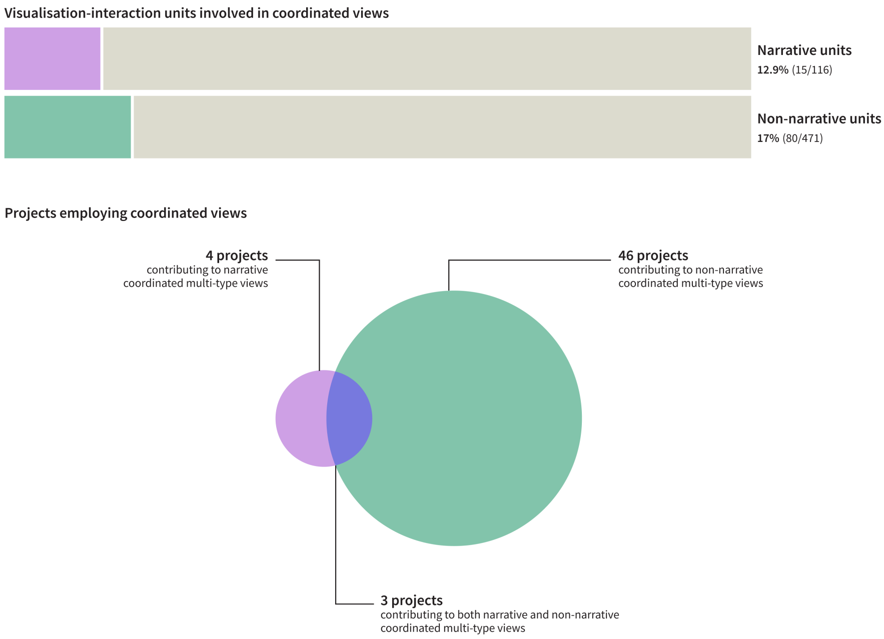

Figure 32 Proportion of coordinated views across narrative and non-narrative units (top) and projects that include coordinated views in narrative and non-narrative settings (bottom).

Maps and bar-based charts remain the most frequent techniques across both contexts, but timelines (33.3%, 5/15 vs. 12.5%, 10/80), plots (26.7%, 4/15 vs. 10%, 8/80), and cluster/set visualisations (26.7%, 4/15 vs. 2.5%, 2/80) gain relative weight in narrative settings. Differently, line charts (6.7%, 1/15 vs. 23.8%, 19/80) and networks (6.7%, 1/15 vs. 20%, 16/80) are much less frequent in narrative coordinated units. Some types appear exclusively in one context: hierarchical diagrams and treemaps only in narrative; word clouds and area charts only in non-narrative (Figure 33).

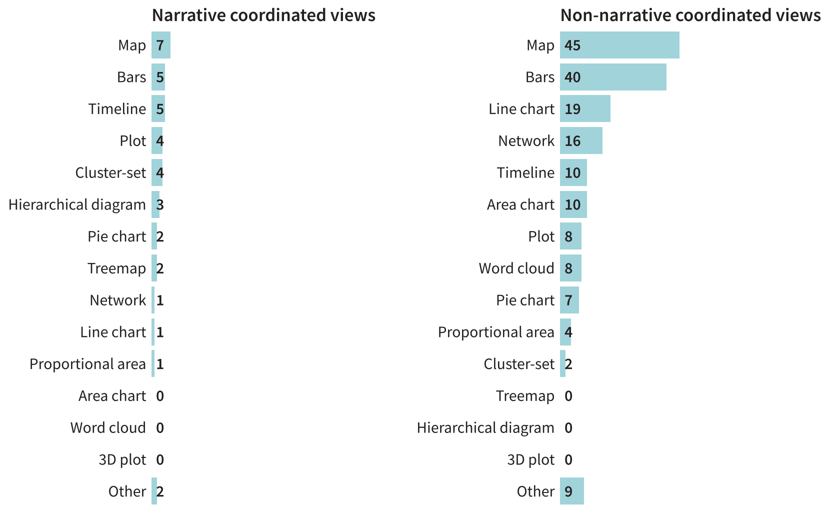

Figure 33 Frequency of visualisation techniques in narrative (left; n = 15) and non-narrative (right; n = 80) coordinated views.

Maps most often occupy the primary role in both contexts, but other visualisation techniques diverge (Figure 34). Networks (6 cases) and line charts (3 cases) follow as primary in non-narrative coordinated views but never do so in narrative ones. Timelines serve as the central visualisation once in each context, while cluster and set visualisations assume a leading position more often in narrative (4 times) than in non-narrative units (2 times).

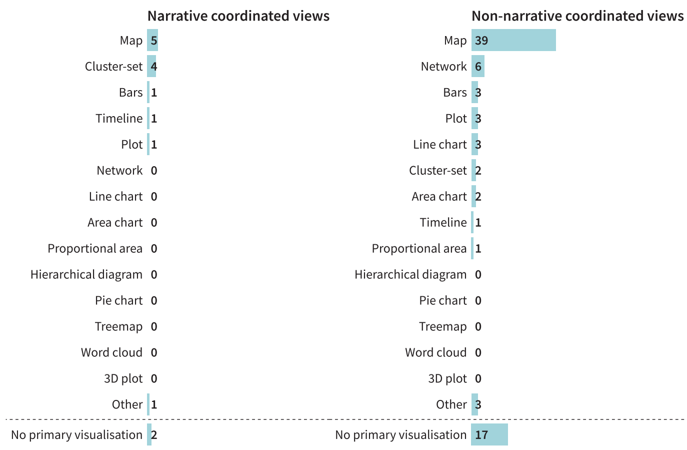

Figure 34 Frequency of visualisation techniques serving as the dominant type in narrative (left; n = 15) and non-narrative (right; n = 80) coordinated views.

7. Discussion

DH projects mostly contain a few visualisation-interaction units. Projects with one visualisation-interaction unit are by far the most common, suggesting a strong preference for simplicity or small-scale initiatives focused on a single analytical or communicative task. This also suggests that usability, resource constraints, or audience expectations may strongly constrain design complexity. Outlier projects with 16+ units or high reconfiguration rates stand out as strongly experimental or research-driven. The high representational diversity of this subset possibly foregrounds the use of multiple analytical perspectives or a highly segmented view of the dataset. However, given the methodological framing of the study, it is not possible to further assess the contribution of the involved units and reconfigurations to project quality based on quantity alone.

Interaction changes are overwhelmingly preferred over changes in narrative or temporality. This points to interaction as the "default" design strategy in DH. The dominance of simple interactions (highlight, navigation, selection) versus the rarity of advanced ones (brush and link, aggregation, drill) could reflect limited technical expertise or a preference for low-threshold/high-access designs. Static visualisations still account for 20% of cases—raising the question of how far DH projects need interactivity at all, and whether interactivity is sometimes more ornamental than functional.

Changes in visualisation type and visualisation variant are rare. Instead, reconfigurations (e.g. multiple versions of maps or bar charts) appear as a middle ground between static and transformative designs. We could frame this phenomenon as a compromise in two ways, namely: (1) small moves toward complexity while keeping usability manageable, or (2) a simplified way to handle the "one view is not enough" principle (Dörk et al. 2022), offering users multiple perspectives by repurposing the same visual form rather than through visualisation type transformations. This suggests that interpretive flexibility is often pursued by constantly re-adapting a stable set of visual solutions rather than through a diversification of techniques.

Moreover, the limited and recurring set of visualisation techniques and the often-small interaction-based diversification between reconfigurations seem to point towards a set of pragmatic choices driven by ease of implementation and reliance on familiar tools (e.g. charting libraries) and visual forms. Indeed, maps and bar charts dominate—suggesting a cultural conservatism, privileging spatial and distributional perspectives. This may reflect different factors and their potential interplay, including the will to leverage and support audience familiarity (favouring ease of interpretation and reduced cognitive load); possibilities and constraints of commonly used DH platforms (e.g. StoryMap[6]); and disciplinary traditions sustaining standardisation, reproducibility, and reuse in DH visualisation practices. It can also be argued that the adaptability of maps makes them suitable for diverse framings, being frequently reconfigured through interaction capabilities, narrative settings, or temporal encodings. Again, rare use of visualisation transformations, visualisation-variant transitions, and advanced interaction suggests a cautious approach, privileging legibility and sustainability over experimentation.

Coordinated views—that can support comparative or contextual reasoning—remain relatively rare and, when present, are built on predictable pairs (maps + bar charts, maps + timelines). This suggests limited innovation in multi-visualisation design, possibly due to technical difficulty,

[6] https://storymap.knightlab.com/.

but also a preference for familiar, easily interpretable pairings. The centrality of maps in such multi-type coordinated views reinforces their paramount role as the anchor visualisation in DH projects.

In this context, tool characteristics re-emerge as a central issue. While reusable tools represent valuable resources, the influence they have on scholarly practices remains unclear. On one side, the recurrent use of similar visualisation types and their associations could reflect the homogeneity of data; on the other, this may indicate how the—often necessary—reliance on reusable solutions restricts representation possibilities to the predefined forms offered by the tool (e.g. a frequent use of DARIAH Geo-Browser[7] leading to a higher number of associations between maps and timelines). While often fundamental, we argue that such an approach might be limiting interpretative opportunities related to comparative and contextual perspectives. Overall, these patterns suggest that DH visualisation practice is driven more by available infrastructure than by conceptual design. We argue that the exploratory, conservative approach characterising DH visualisation could benefit from the investigation of new design spaces to foster deeper and richer interpretive engagement.

Only when looking separately at narrative and non-narrative contexts can we better appreciate distinct repertoires and research trends. Narrative settings reduce interactional complexity but emphasise plots, timelines, and cluster/set views. This suggests a tension between storytelling and exploration, wherein narrative projects trade away user agency (filters, advanced selection) in favour of controlled sequencing or framing. Conversely, non-narrative projects lean toward open-ended exploratory interaction, including more coordinated views, aligning with expected data exploration goals. Hybrid projects show how DH teams attempt to balance these competing demands, sometimes unevenly. Still, the limited number of narrative and hybrid projects reveals the lack of design research in favour of reusable, out-of-the-box, exploratory solutions. In particular, narrative units derive from the use of storytelling tools with limited customisation and pre-built interactions (Battisti and Daquino 2026), which risks oversimplifying complexities where storytelling instead should be able to unfold them.

In summary, our findings are evidence of a field still negotiating between tradition and innovation, usability and experimentation, exploration and narrativity.

The study presents, however, some limitations. While the corpus is large enough to support representative conclusions, insights derived from smaller subsets cannot be fully generalised. The chosen granularity—focusing on visualisation-interaction units rather than individual charts—allows us to examine overall project choices without binding results to their actual distribution. We cannot exclude that this approach may overlook patterns visible at the level of single visualisation occurrences.

8. Conclusion

In this work, we advance the study of web-based DH visualisation practices by examining the interplay of visualisation, interaction, and narrative contexts, introducing a new level of analysis based on visualisation-interaction units. The quantitative analysis using this fine-grained perspective allows us to address limitations and reveal patterns that were invisible in previous studies addressing trends at the project level, although limited in scope since an evaluation of

[7] https://de.dariah.eu/geobrowser.

actual engagement is not provided. Our findings highlight that DH projects prioritise reproducibility, convenience, and ease of use. While potentially beneficial to meet audience familiarity, the caution and conservatism emerging from the use of familiar and ready-made solutions—often illustrating similar data dimensions with rare experimentation—may come at the cost of interpretive richness, as well as the potential long-term sustainability of tool-dependent solutions. Multi-visualisation units, highly diversified reconfigurations, coordinated views, and more complex interactions that foster interpretation and disclosure of multiple perspectives remain relatively rare, since they generally require greater development effort and thus reduce ease of maintenance. Explorative, non-narrative settings dominate even in sites of negotiation (i.e. hybrid projects), where narrative and non-narrative contexts also often remain separate.

Overall, this study contributes a more detailed understanding of how visualisation and interaction practices are leveraged in DH projects, providing a foundation for future research aimed at enhancing interpretive depth and promoting the use of visualisations as epistemic tools rather than ornamental data summaries.

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