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Why should we care?
Exploring Pathos in Data Visualization

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Verena Ingrid Prantl BA

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Abstract

Aristoteles sagte, dass wir beim Überzeugen oder Argumentieren drei Dinge ausbalancieren müssen: Logos (Vernunft), Ethos (Moral/Glaubwürdigkeit) und Pathos (emotionaler Appell). Während Logos und, in jüngerer Zeit, auch Ethos als Aspekte betrachtet werden, die in den Naturwissenschaften nicht vernachlässigt werden sollten, wird Pathos kritischer gesehen. In den Geisteswissenschaften ist dieser Unterschied zwischen den drei Überzeugungsmodi nicht so ausgeprägt, wie die vielfältige Forschung zu Pathos zeigt. Diese Arbeit untersucht das Konzept der Emotion (Pathos) durch die Synthese von Erkenntnissen aus verschiedenen wissenschaftlichen Disziplinen, wobei besonders die Perspektive der Vergleichenden Literaturwissenschaft betont wird. Die methodischen Ansätze, die verwendet werden, sind in der Vergleichenden Literaturwissenschaft verwurzelt und schöpfen umfassend aus einem historischen und aktuellen Korpus theoretischer Literatur, um diese Analyse zu informieren. Das Hauptziel besteht darin, die Machbarkeit zu bewerten, das ästhetische Konzept des Pathos in die Datenvisualisierung zu integrieren, um das Verständnis von Daten zu verbessern. Um Daten für Menschen greifbarer und verständlicher zu machen, ist es essenziell, sie mit der menschlichen Denkweise zu verbinden, was durch den Einsatz rhetorischer Mittel wie Pathos erreicht werden kann. Diese Arbeit fungiert als intellektuelle Brücke, die die Welten der Datenvisualisierung und des Pathos miteinander verbindet. Auf diese Weise überbrückt sie die Kluft zwischen wissenschaftlichen Informationen und ihrer Wirkung auf Individuen und verbessert unser Verständnis von Datenvisualisierungen. Sie kombiniert auch Ansätze aus den Naturwissenschaften mit den traditionelleren Methoden der Vergleichenden Literaturwissenschaft. Zudem hebt sie die Rolle des Datenstorytellings und der visuellen Narrative in der Vergleichenden Literaturwissenschaft hervor und betont, wie Datenvisualisierung als kraftvolles Kommunikationsmittel dienen kann, während sie gleichzeitig das Verständnis und Interpretieren von Daten fördert.

Abstract

Aristotle said that when we persuade or argue, we need to balance three things: logos (reason), ethos (morality/credibility), and pathos (emotional appeal). While logos and, more recently, ethos are discussed as aspects that should not be neglected in the natural sciences, pathos is viewed more critically. In the humanities, this discrepancy between the three modes of persuasion is not as pronounced, as demonstrated by the diverse body of research on pathos. This thesis investigates the concept of emotion (pathos) by synthesizing insights from various scientific disciplines, particularly emphasizing the perspective of comparative literature. The methodological approaches used are rooted in comparative literature, drawing extensively from a historic and timely corpus of theoretical literature to inform this analysis. The primary objective is to assess the viability of incorporating the aesthetic concept of pathos into data visualization to enhance data comprehension. To make data more tangible and comprehensible for people, it is essential to connect them with the human way of thinking, which can be achieved by using rhetorical devices, such as pathos. This thesis acts as an intellectual link, connecting the worlds of data visualization and pathos. By doing so, it bridges the gap between scientific information and its impact on individuals, enhancing our understanding of data visualizations. It also combines approaches from the natural sciences with the more traditional methods found in comparative literature. Also, it highlights the role of data storytelling and visual narratives in comparative literature, emphasizing how data visualization can serve as a powerful communication tool, while also enhancing comprehension and engagement.

1 Introduction

In the face of today's global challenges, data visualizations need to become more effective and tangible, to counter the increasing scientific skepticism (Većkalov et al. 2024). Rhetoric serves as a powerful tool to enhance the impact of data visualizations, not only to inform but also to inspire action. Through the skillful use of rhetorical strategies, data presentations have the potential to captivate and motivate audiences to address pressing issues proactively. Appealing to an audience's emotions, i.e. using pathos, is to this date a relatively neglected aspect in data

visualization research. Emotions are integral to how we connect, understand, and engage with the world around us. Aristotle contended that in rhetoric, appealing to an audience's emotions serves to foster goodwill toward the speaker and captivate their attention (Aristotle 2018, p. 146). In data visualization, where complex information is communicated, emotion is crucial. They are integral to the sense-making process, potentially shaping how we interpret and engage with the data presented (Dwyer et al. 2021; Kennedy & Hill 2018). It is not something we can simply overlook or dismiss, rather, we need to acknowledge and proactively address this aspect. In doing so, we transform not only the way we communicate but also the way we understand and respond to data-driven insights (Heath & Abrahams 2022). Still, there is a traditional separation of emotion and reason, particularly concerning rhetoric research, within the scientific context. Furthermore, within the domain of data visualizations, particularly in contemporary times, there is an emphasis on practical design principles, adhering to a rigorous functionalist approach. Emotion-enriching strategies are still considered controversial; designers such as Nigel Holmes (1991), who incorporated emotional elements into data visualizations, contrast with those like Edward Tufte, who calls such designs "bombastic hype" (Kostelnick 2016, p. 122). However, the perceived ignorance of pathos or emotions in general in science, preferably in the nautical sciences, seems to be experiencing a counter-trend. The fact that a paper with the title "Affective Learning Objectives for Communicative Visualisations" (Lee-Robbins & Adar 2022) wins the "Best Paper Award" at one of the largest conferences in the field of scientific visualization, information visualization, and visual analysis is a definite indication for a new trend in this area. Even though not all areas call pathos by that name, but instead use terms such as "empathetic emotion", "affective intents" or "emotional appeal" to describe it, in essence, this is still exactly what Aristotle considered pathos more than 2,000 years ago. Nevertheless, it is important to provide a sound theoretical basis and to bring together knowledge from the different disciplines to generate a basis from which both the natural sciences and the humanities can draw and benefit. Since this task would probably correspond to a manifesto, this Master's thesis focuses on a limited sub-area and places the following research question in the center: To what extent can historic theories of rhetoric and pathos be transferred to the field of (data)

visualizations, and how does pathos manifest itself in (data) visualizations and what advantages and disadvantages might the implementation of pathos entail for this field. Therefore, this work should also be seen as a contribution to a development that uses models of literary and cultural studies transmedial and thus also points out that storytelling has long since ceased to be exclusively linked to the medium of books and words alone, but is also being used as a rhetorical device in films, video games, and even data visualizations. This is evidenced by recent research on data storytelling or data-driven storytelling (Knaflic 2015). Considering the necessity for increased interdisciplinary cooperation within this domain, it should be noted that this is by no means to be considered a disadvantage, but rather a possibility, quite along comparative lines, to make terms and concepts that appear universally, but in a slightly different disguise, recognizable and describable. Furthermore, the incorporation of interdisciplinary strategies and techniques designed to evoke emotions in individuals holds promise for making data visualizations more engaging and memorable (Wang et al. 2019). Within the diverse disciplines of the humanities and social sciences, the term "pathos" remains without a universally agreed-upon definition. Efforts to delineate its meaning frequently encounter challenges in terms of precision and delineation. The term "empathetic emotions" in this case is used as an approximation to pathos, and narrows down emotions in general to those that affect a person's soul (Gessmann 2002, Rees 1972). Still, talking about empathetic emotions is challenging. For example, the terms "sympathy", "compassion", or "empathy" are often used as synonyms, which can lead to confusion (Boy et al. 2017). So, why exactly is the rhetoric of pathos in data visualizations of importance at all?

A strong argument in favor of emotions in data visualizations is that emotions tie into experiences and are thus part of the sense-making process, which may mediate cognitive outcomes of engaging with data visualizations (Dwyer et al. 2021; Kennedy & Hill 2018). Since visualizations generally aim to evoke meaning in data, this approach to using emotion in data visualization seems highly relevant (Wang et al. 2019). The goal of evoking empathetic emotions in the recipients is not reprehensible, but a way to reach people with those data visualizations as a part of successful (data) storytelling. Up to this point, there is no consensus in the theo-

retical approach on enriching data visualizations with empathetic emotions. On the one hand, this might be because empathetic emotions are difficult to measure, as are emotions in general, and, on the other hand, feelings and emotions remain individual in large parts (Kennedy & Hill 2018). However, there are approaches to make data visualizations more connected to people: for instance, evidence shows that the interpretation of data in visualizations can be significantly influenced depending on the way they are framed (Hullman & Diakopoulos 2011). Daniel Kahneman & Amos Tversky discuss this topic in their book "Choices, Values, and Frames" (2000) where they discuss the cognitive and psychophysical factors influencing the decision-making process, thereby offering a new approach to the utility theory of choice. They argue that framing effects have an impact on people's decisions and experiences: "framing of an expenditure as an uncompensated loss or as the price of insurance can probably influence the experience of that outcome. In such cases, the evaluation of outcomes in the context of decisions not only anticipates experience but also molds it" (Kahneman 2012, p. 55). Factors and techniques for communicating empathetic emotions, such as emotional frames, are typically confined to additional materials surrounding data visualizations to cater to the emotional aspect of the audience. This prompts the question: how can the visualization itself be tailored to enhance communication engagement?

It is worth noting that pathos, or the deliberate evocation of emotions in a target audience, is often perceived as a "problematic category" (see Zumbusch 2010) and, consequently more prone to be neglected within scientific disciplines. This phenomenon of neglecting pathos is not confined solely to the natural sciences but is also observed across other academic domains (Busch & Därmann 2007, pp. 7-8; Kostelnick 2016). Therefore, the complexity and implications of this subject require a comprehensive analysis.

2 Context & key concepts

Numerous modern rhetoricians have already dealt with emotional appeals and their effects and characteristics, whereby George Campbell probably is one of the better-known representatives,

and his theory Philosophy of Rhetoric (1776) ranks among the most detailed. He states that the emotional (e.g. pathos) and the rational (e.g. ethos and logos) arguments need to be in balance for a speaker to convince an audience. In doing so, Campbell refers both to Aristotle's rhetoric but also to a certain extent to other theorists such as Edmund Burke (Kostelnick 2016). Campbell thus presents a taxonomy of different circumstances that make the emergence of emotional appeals possible in the first place. He specifically identifies seven different circumstances, which he describes in great detail and substantiates with theoretical evidence. Since George Campbell has done profound work regarding the elaboration of a taxonomy that is also relevant for more recent scientific studies, it forms a theoretical approach for this work as well, which is adapted and customized for the purposes and demands of the visualization community. To date, there has been limited research consolidating diverse viewpoints on emotions in data visualization, marking a notable gap in the literature. This thesis addresses this gap by embarking on a comprehensive review that not only provides a historical perspective on the role of pathos in data visualization but also briefly outlines potential pitfalls associated with the engagement of emotions in this context. The synthesis of insights extends across various scientific domains, encompassing social sciences, economics, and humanities. Significantly, in the field of literature studies, this thesis takes a unique approach by introducing innovative methods that closely connect emotions (pathos) with how data is displayed. This deliberate combination represents a pioneering effort, adding depth to discussions about emotions in data visualization. By using analytical tools and interpretative frameworks from comparative literature studies, this research aims to give a detailed understanding of how emotions and visualizing data are being used together. This integration of literary perspectives into the discussion about pathos and data visualization not only enhances the understanding of these topics but also lays the foundation for future research inspired by the rich traditions of comparative literature. The primary contributions of this thesis are: (a) providing a unique and multidisciplinary theoretical foundation including a historical perspective (b) utilizing tools and frameworks from comparative literature to gain a deeper insight into the workings of pathos in data visualization (c) offering a better understanding of how pathos can influence the perception of data visualizations and how pathos

manifests in data visualizations, by discussing concrete techniques. This inclusive approach presents a novel perspective on the intricate interplay of emotions and aesthetics in data visualizations, paving the way for further empirical exploration and emphasizing the necessity of ongoing research in this field.

2.1 Definition of important concepts

Considering the context of this thesis, it is important to have clear definitions for the concepts of rhetoric, pathos, and aesthetics. These definitions will serve as foundational references for the subsequent discussions and analyses within this thesis.

Pathos in rhetoric encompasses techniques and emotions, referring to both the speaker's and the audience's emotions (Corbett 1999, pp. 87-88). Aristotle described these emotions as "those affections, accompanied by either pain or pleasure, that cause people to undergo a change and modify their judgments" (Aristotle 2018, p. 61). He also linked them to catharsis in ancient theater (Ueding 1976, p. 31). Quintilian distinguishes between violent emotions (pathos) and calmer ones (ethos). Ethos is the character a speaker reenacts, while pathos aims to induce emotions in the audience. This distinction between violent and non-violent emotions was questioned by other scholars, leading to a lack of precision in the definition (Corbett 1999, pp. 87-88). Although an unethical manipulation of emotions exists, it is argued that emotional appeal should not be condemned in general. Emotions can be stimulated indirectly by looking at objects or situations (Lanham 1991, p. 111). This appeal to the audience's emotions can entail a variety of emotions, such as "anger, pity, fear, and so on, and their opposites" (Aristotle 2018, p. 61). But because of its transforming meaning, depending on the field in which it is being used, finding a unified description of pathos in relevant literature remains difficult (Rees 1972; Sulzer 1771, pp. 884-885). Attempts to define pathos often lack clarity and rigor. Terms like empathetic emotions and emotional appeals can be used as an approximation to pathos and narrow down emotions in general to those that "affect a person's soul" (Gessmann 2002, pp. 724-725). Johann Georg Sulzer acknowledged that the use of big words is not essential for creating pathos in literature. However, Sulzer did not provide a precise definition of pathos

and instead listed what it is not. He noted that pathos is commonly found in tragic opera and religious matters. Sulzer further explained that the true essence of pathos is not just about the presence of emotions but rather the intensity and duration of the feelings expressed. In the arts, superficial emotions lack the necessary depth to evoke pathos and instead come off as comical. (Sulzer 1771, pp. 661-662).

Aesthetics is considered a philosophy of art since Hegel and it is defined as a theory of the beautiful. In the 18^{th} century, it expanded to encompass themes such as the sublime, magnificent, elegant, and graceful, as well as the ugly and grotesque, forming a comprehensive theory of aesthetic values, their experience, and evaluation (von Kutschera 1988, p. 1). Empirical aesthetics, in contrast to traditional beauty-centric views, focuses on intense emotions and interactions with objects. It encompasses research on beauty, aesthetic pleasure, preferences, and art perception, evaluation, and creation. Originating in the 19^{th} century with Gustav Fechner, this field has recently gained interest from neuroscience, psychology, and the wider public (Brielmann & Pelli 2018). This has led to defining aesthetics as the study "of how and why sensory stimuli acquire hedonic value" (Skov & Nadal 2020, p. 630). Aesthetic experiences are closely connected to the stimulation of the brain and the experience of pleasure. Additionally, evolutionary factors, such as symmetry and attractiveness, play a role in shaping aesthetic preferences, serving as indicators of health and mate quality (Brielmann & Pelli 2018).

Rhetoric is one of the seven liberal arts and it emerged in the early fifth century BC. It originally focused on persuasive public speaking, but it has expanded to include written communication (Lanham 1991). Aristotle defined three kinds of rhetoric because this is "how many different kinds of audience there are for speeches" (Aristotle 2018, p. 12). The audience serves as observers or judges, determining the purpose of the speech. This leads Aristotle to conclude, that there are three rhetorical speech types: deliberative, judicial, and epideictic (ibid. pp. 12-13). Throughout its history, it has oscillated between specific technique-oriented concerns and broader ethical considerations, leading to varied definitions. Cicero claimed that there are three main functions for an orator: to teach, to please, and to move (Lanham 1991, pp. 131-132). Aristotle on the other hand developed the rhetorical triangle, with pathos (emotional appeal),

ethos (ethical concerns), and logos (logic) as cornerstones (Corbett 1999, pp. 20-24). However, defining rhetoric's scope has proven challenging, exemplified by the overlapping domains of persuasion, such as philosophy, leading to enduring debates (Lanham 1991, pp. 131-132). Aristotle defined rhetoric as "a counterpart of dialectic in that both are concerned with the kinds of things that in some sense are available for everyone to know about, and do not belong to a distinct branch of knowledge" (Aristotle 2018, p. 3). However, in rhetoric, aesthetic categories, such as pathos, are regularly used to improve communication. George Campbell defines rhetoric as a way of conveying not only ideas but also emotions and intentions. It is the skill of adapting language to its purpose. This makes rhetoric versatile, covering a wide range of communication (Weinsheimer 2004).

Narrative involves telling "small stories" about everyday events. It includes various types of storytelling, ranging from personal experiences to fantasies. Key aspects of the narrative include the teller, the tale itself, and the act of storytelling. Recipients play a central role, engaging in both actual and virtual participation through questioning and dialogue. Narratives typically follow a temporal sequence of events, although conversational narratives may exhibit more complex structures. Recipient design ensures that the narrative is tailored to the audience's needs and interests (Rühlemann 2013, pp. 37-39).

Storytelling "is how we build and create our own identities and then present them to others to negotiate our social, professional, and personal relationships in conversational contexts" (Wilson 2022, p. 3). Storytelling is not merely a form of entertainment but a cognitive exercise, akin to solving puzzles, that promotes mental agility and well-being. It serves as a tool for individuals to navigate and make sense of their experiences. Additionally, storytelling is a social mechanism that fosters connection and belonging, mitigating feelings of isolation and loneliness. Thus, storytelling serves as a multifaceted process that promotes cognitive, emotional, and social well-being (ibid., pp. 17-18).

Having established a foundation encompassing emotional appeals, aesthetics, and rhetoric in data visualization, as well as a more general introduction to narrative and storytelling, the subsequent section delves into relevant literature and research, providing a broader context for

this thesis' focal points.

3 Related work

Emotion, and particularly the deliberate evocation of empathetic emotion, has often been viewed with skepticism in the scientific community, seen as an incongruity in the stringent pursuit of knowledge. Nonetheless, emotions can play a valuable role in science and data communication by facilitating the translation of abstract numbers into forms that are more relatable for people. Chip Heath highlights this importance by arguing, "If we don't translate numbers into something more tangible, we're going to sacrifice in a big way" (Heath & Abrahams 2022). Employing emotions in data presentation is a strategy to achieve this translation, recognizing emotions as catalysts for meaningful human action (ibid.). Research conducted by Scott and Paul Slovic (see Slovic & Slovic 2015a; Slovic 2007) supports this view, demonstrating that as numerical data become larger, individuals tend to become desensitized, because "numbers fail to trigger the emotion or feeling necessary to motivate action" (Slovic & Västfjäll 2015 p. 55).

Despite the prevailing trend against incorporating empathetic emotions into information visualizations, some domains are exploring unconventional representations with notable exceptions. Cho et al. (2015) investigated the emotional responses elicited by a plant's expressions when conveyed through an LED output device. Additionally, initiatives in various contexts and utilizing persuasive methods have examined the impact of visualizing emotions on attitudes and behavioral change (e.g., Botros 2016; Cho et al. 2015; Froehlich et al. 2009; Pousman et al. 2007). Of particular relevance to this discussion are personal visualizations, which resonate with the concept of pathos. Huang et al. (2015) have proposed techniques and technologies to improve individuals' understanding of data that pertains to their personal lives, interests, and necessities. In a broader context, the principles of data feminism advocate for recognizing emotions and embodiment in data analysis and interpretation. It stresses that knowledge can be manifested in various forms, and within this framework, emotions are seen as essential instruments for comprehension, remembrance, and data communication. Data feminism

regards visualizations as rhetoric, questioning the effects of framing and challenging the presumed objectivity of data (D'Ignazio & Klein 2020). While data feminism sets the foundation for recognizing emotions in data visualizations, this thesis extends the discussion to Aristotelian rhetoric, analyzing its particular manifestations in data visualizations. Moreover, it discusses techniques and methods designers of visualizations are using to incorporate emotions in this realm. This shows the diversity of this topic within different scientific disciplines. This is why, overall, this thesis probes the interconnectedness of data visualization, literature, and rhetoric, with a primary focus on pathos. It begins with a methodological approach, and from there, it addresses key thematic areas, starting with the synergy between data visualization and literature and proceeding to narrative visualizations. The analysis then examines the rhetorical triangle, offering definitions of the modes of persuasion. The analysis then explores the rhetoric of visuals, including an overview of the ongoing debate surrounding ethos and pathos in science and considerations of the human aspect of visual design. A thorough examination of pathos in data visualization includes an in-depth analysis of emotion, affect, and potential pitfalls as well as an investigation of George Campbell's philosophy regarding rhetoric. The thesis concludes with reflections on limitations, future research directions, and implications, and summarizing the extensive investigation. This structured approach proposes a comprehensive review of pathos, aesthetics, and rhetoric within the sphere of data visualization.

4 Methodological approach

A challenging methodological area comprises literature reviews synthesizing diverse approaches. The multidisciplinary meta-narrative review standard practices outlined by Greenhalgh et al. (2005) were deemed fitting, proposing a framework for systematically searching and evaluating relevant literature within a broad scientific context. In the planning phase, the research question was outlined in a broad, open-ended format: "How does pathos, i.e., emotional appeals, manifest in data visualizations, and how did it change over time?" This ensured the review captured potentially relevant peer-reviewed articles about pathos with or without a connection to data

visualizations. This master's thesis aims to examine the most relevant research approaches to this topic from the humanities, social sciences, and natural sciences, with a particular focus on visualizations. Literature was obtained from databases such as IEEE Xplore, Google Scholar, ScienceDirect, ACM Digital Library, Scopus, and u:search the scientific search engine of the University of Vienna.

To avoid limiting the results to a specific scientific discipline, different search terms and keywords were utilized. For instance, search queries using terms like "pathos" or "rhetoric" ("pathos in data visualizations," "data + pathos," "data + emotion," and "visual rhetoric") were employed to obtain relevant results from the social sciences and humanities. Conversely, the keyword "pathos" yielded almost no usable results in the field of data visualization, prompting the use of more comprehensive variants as queries ("empathetic emotion in data visualization," "data-driven storytelling," "emotional data visualization," "storytelling with data"). The search, restricted to scientific articles about data visualization published in the last 20 years, focused on articles in English and German. Although the historical perspective was relevant, literature was included only back to Aristotle (384-322 BC) in the humanities, considering classical and traditional theories related to pathos and pathos research that can be dated further into the past. In addition to the literature search, citation chains and related sources were consulted to obtain multiple perspectives. Additional relevant search terms were identified ("emotional framing data visualization," "emotional design," "communicating numbers").

The review of the literature revealed a growing trend of articles on empathetic emotions in the data visualization field, indicating its increasing research interest. While focusing on theoretical concepts, empirical studies were also considered, particularly data visualizations, aiming to substantiate existing theories and enhance relevance in the scientific community. The literature review primarily concentrated on theories of pathos in literature and other media, including more general theories of emotion in data visualization and their operationalization. Excluded topics encompassed trust, incidental information visualization, or manipulation with emotion, as they were not central to the research focus, with an already extensive literature body in these areas.

5 Data visualizations & literature: how do they connect?

Literature and data visualization, seemingly disparate disciplines, intersect in storytelling's domain, both wielding the power to convey complex ideas and information. The former communicates through words and mental imagery crafted by the author, while the latter employs graphs, charts, and other visual tools to tell a story. Each medium seeks to forge a bond with its audience and impart a message, whether it unfolds within a fictional narrative or a data-driven exposition. This synergy of narrative and visual expression allows literature and data visualization to inform, entertain, and engage audiences in novel and profound ways (e.g., Matei & Hunter 2021; Mordvinova & Nieves 2020). The subsequent analysis considers the extent to which data visualizations and literature are analogous and interwoven, emphasizing the rhetoric-aesthetic dimension of pathos. In literature, pathos is a mechanism that elicits emotional responses, fostering a connection between the reader and the characters. Data visualization, by similar means, harnesses pathos to align the viewer's feelings with the depicted data (Lund 2022). The application of pathos, employed in both literature and data visualization, aspires to engage audiences, stir emotions, and communicate a potent message. This convergence presents an exceptional avenue to investigate pathos across varied communicative formats and its effect on the recipient. Pathos, as articulated by Aristotle in his work on poetics and rhetoric, serves multifaceted rhetorical purposes. It encompasses the protagonist's tribulations and the audience's emotions, which Aristotle contended should lead to cathartic absolution through the hero's trials. Furthermore, pathos can also arise when speakers use rhetorical techniques to evoke certain emotional reactions in their audience (von Koppenfels & Zumbusch 2016, p. 14). While visual arts and music convey sentiment through their respective channels, the written word operates through an alternate mechanism—emotion transmitted via language. Von Koppenfels & Zumbusch (2016) assert that literature is "emotion mediated by language" (p. 17), and as such, serves as a symbol of the intimate connection between words and emotions (ibid. pp. 16-17). This naturally leads to the conclusion that literature's pathos emerges from the narrative level. As per Stephan Leopold's observations, when readers deeply resonate with a character's situation and experience an "arousal of pity" (Leopold 2020, p. 272), this is an outcome of narrative-driven pathos,

or the essence of the story itself (ibid. pp. 271-272). However, to integrate emotional aspects of data visualizations within the purview of literary studies, an essential question arises: What is the correlation between data visualization structures and concepts, and those pertinent to literary studies? One crucial facet is that data visualizations inherently strive to communicate, one way to do this is through storytelling. As expounded earlier, narratives play an important role in literature and similarly, they are fundamental to data visualizations. Conversely, maps and similar visual representations have been effectively incorporated in literature. Scholars including J. B. Harley, Denis Wood, John Pickles, Michael Curry, and Matthew Edney are known for their approach to seeing maps as more than mere geographical depictions, but also as repositories and conduits of information of power. Harley, in his writings from the 1980s and 1990s, adopted Michel Foucault's and Jacques Derrida's theories, injecting a poststructuralist lens to critique traditionally accepted interpretations of maps in literature as straightforward communicative instruments (Crampton 2001, p. 236). Such insights affirm the legitimacy of comparing these distinct genres of storytelling (Süss 2006, p. 64). Narrative theory, which includes narrative methodologies within the scientific dialogue, can be seen as a sequence of incidents forming a coherent narrative if they maintain the continuity of the subject and convey a comprehensive meaning. Therefore, a text, video game, or data visualization belongs to the narrative theory domain if its unfolding events sustain a story and cohere in an integrated manner (Carpentier & Lourdeaux 2014, p. 28).

5.1 Narrative data visualizations

Storytelling has been used for centuries and there is extensive literature on storytelling in various disciplines, such as Linguistics, Anthropology, Folklore, Sociology, Cultural Studies, Communication, Psychology, and Cognitive Science (Mandelbaum 2012). However, the immense technical progress of the last decades has not left the field of storytelling untouched and has contributed to the fact that this art form is constantly changing: For example, making use of interactivity can lead to the fact that the moment of surprise or discovery is felt more intensively (Figueiras 2014, p. 47), as people gain more agency. Nevertheless, the incorporation

of narrative elements into the realm of (natural) science is currently a subject of ongoing discussion, with questions arising as to whether such elements should be utilized at all. After all, storytelling does not necessarily enjoy a good reputation in the world of science, as it is often associated with manipulation. However, experts to date have recognized that complex content can be made more comprehensible to people outside their domain if it is linked to a narrative – in other words, if "a story is told" (Dahlstrom 2014, p. 13614). Some researchers, including Dahlstrom (2014) and Matei & Hunter (2021), even consider science as a form of storytelling. This perspective is not entirely novel, with examples from history demonstrating the use of storytelling through data visualizations. Notably, Minard's Map, which charts Napoleon's ill-fated campaign against Moscow in 1812, and John Snow's map illustrating the cholera outbreaks in London in 1854, exemplify the longstanding effectiveness of storytelling in data visualizations (Liu et al. 2020, p. 2033).Therefore, the underlying composition and arrangement of these visual representations inherently convey a narrative. They may employ a range of narrative techniques, such as annotations, highlighting, or even animated transitions – the latter applicable particularly in digital mediums (ibid. p. 2033).

5.2 Narrative elements & strategies in data visualizations

The Oxford English Dictionary offers the following definition for the term narrative: "An account of a series of events, facts, etc., given in order and with the establishment of connections between them; a narration, a story, an account" (Buchanan 2023). This definition underscores the significance of a causal sequence in storytelling (Segel & Heer 2010, p. 1139). The art of storytelling is deeply rooted in human culture (Figueiras 2014, p. 47) and although there are many different forms and models of storytelling in different cultures, the core remains consistent: a story includes an introduction, a main part, a conclusion, moments of suspense, and moments of surprise (Figueiras 2014, p. 47; Segel & Heer 2010, p. 1139). Narratives, while central to the arts and entertainment, are equally critical in the domain of information communication. With the rising prominence of data and statistical information, research focusing on the efficacious application of narratives in this domain, particularly within the visualization

community, has expanded. Initiatives have included translational endeavors from other disciplines to enhance narrative data visualization design (Wang et al. 2019). In recent years, various researchers have explored different narrative strategies, focusing on semiotics, critical theory, and journalism. For example, Segel & Heer (2010) as well as Hullman & Diakopoulos (2011) have developed narrative strategies for visualization based on visual rhetoric. Segel & Heer's approach emphasized structure and general advice for creating narrative visualizations. Hullman & Diakopoulos went further and proposed an analytical framework for visualization rhetoric that spans editorial levels, including the data itself, its visual representation, textual annotation, and also aspects such as interactivity. They also presented a range of techniques for visualization rhetoric, such as omission, metonymy, data provenance, representation of uncertainty, identification, obfuscation, contrast, classification, redundancy, typographic emphasis, irony, similarity, individualization, anchoring, and filtering (Figueiras 2014 p. 48). The connection between the study of literature, broader humanities subjects, and the practice of data visualization becomes visible: Several terms and notions are transported from one medium to an other, creating novel scientific discourses while maintaining their fundamental principles and theoretical underpinnings. The phenomenon of transmediality surfaces when concepts migrate seamlessly from one medium to another, raising the inquiry: Can data visualizations be regarded as embodying a transmedial narrative strategy?

5.3 Data visualizations as a narrative genre

When discussing the transfer of well-researched and established concepts from certain domains, such as cultural, scientific, or political spheres, into a different medium or area, the notion of "transmediality" often emerges. It is a compendium of the term "medium" – referring to the conduit of communication or mediation – and the prefix "trans-," from the Latin meaning "beyond, across." The field of transmediality is especially interested in phenomena where something transcends its technical or material limits to reappear in one or more alternate media forms (Schmidt 2017, p. 251). Simultaneously, it becomes apparent that the discipline of literary studies maintains a somewhat ambivalent association with research on transmediality or "intermediality", ac-

cording to Wteczorek (2012). This duality arises from disparate cognitive concerns within these fields. Furthermore, it is underpinned by inquiries regarding the temporal parameters and criteria governing the classification of a phenomenon as intermedial. Consequently, the emergence of a novel configuration termed "mixed media" (Wteczorek 2012, p. 34) further complicates this relationship. In this context, two forms can be fundamentally distinguished, namely "soft" and "hard" intermediality. Traditionally, literary studies have predominantly emphasized soft intermediality, which involves instances in which textual references to other media are made. On the contrary, hard intermediality, encompassing the broader transfer or integration of text with other media (e.g., photo-text narratives by W.G. Sebald), has traditionally not gotten any significant attention within the discipline. However, the growing importance of hard intermediality is becoming evident, partly attributable to the pervasive transformations in media and the corresponding imperative for literary studies to adapt to these changes (ibid.). Intermediality is used to describe phenomena that occur at the intersection of various media. It broadly encompasses any phenomena situated between different media formats. In contrast, "intramediality" refers to phenomena within a single medium without crossing the boundaries to other media, such as literary references to a specific text or literature in general within the same medium (Rajewsky 2002, pp. 12-13). "Intermediality" on the other side can be illustrated by using the example of a music video that combines visual and musical elements. This creates a creative interface between the media of film and music that transcends the boundaries of the individual media. In contrast, transmediality, is referred to when a particular subject matter or aesthetic is manifested across diverse media without the necessity for a specific original medium.

Within this context, the narrative reflects the human ability to organize and convey events in a meaningful way. This ability to integrate temporal sequences into structures forms the basis for narratives. The choice of medium, be it novel, film, or comic, influences the representation of ideas, as each medium has its structures. Nicole Mahne sees in a transmedial approach the transcendence of the specifics of individual genres and considers the narrative as an overarching principle that works in different media. Transmediality describes phenomena that can be expressed in different media without requiring an origin. The introduction to transmedial narra-

tive theory examines the possibilities and limits of time and space organization, communicative interdependencies, and character perception in different media (Mahne 2007, p. 9; Rajewsky 2002, pp. 12-13). Examples illustrating this phenomenon include the incorporation of biblical motifs into films, paintings, and literature, as well as the integration of the aesthetic-rhetorical concept of pathos into the domain of data visualizations. This scientific approach is not entirely unprecedented. The narratologist Marie-Laure Ryan identified early instances of cross-media phenomena in Greek antiquity, notably in the theories of mimesis by Aristotle and Plato, defining how one form of representation can imitate another. Additional scholars posit the influence of intermediality in Lessing's contemplations of the Laocoon group, questioning how the expressive means of sculpture can narrate, compared to a traditional literary text (Schmidt 2017, p. 251). These explorations into "hard" intermediality contrast with the historical focus of literary studies, which has largely gravitated towards softer forms of intermediality (Wteczorek 2012, p. 34).

5.3.1 Transmediality in science: considerations

When analyzing different narrative genres such as novels, comics, films, audio plays, and hyperfiction, decisive differences in their representational ability can be identified. Nicole Mahne (2007) presented an introduction to transmedial narrative theory, which is characterized by a comparative analysis of different narrative forms. One of her contributions is a presentation of narrative genres in a table, which is now extended by an additional column, as depicted in Table 1. This new column is specifically dedicated to data visualizations. The expansion of the table underlines the classification of data visualizations as a communicative medium within the context of narrative genres to emphasize that data visualizations contain narrative elements and can occupy a relevant place in transmedial narrative theory. In her comparative analysis of narrative genres, Mahne has presented several characteristics to highlight the differences and similarities between the individual types of narratives across different media (Mahne 2007, p. 128). These will now be explained and categorized briefly. The "visual channel", for example in comics and films, uses "images" and "text", while the "acoustic channel", especially in radio

plays, relies on elements such as "speech" and "sounds". The "reception time", i.e. the time required to grasp a story, varies depending on the medium. "Time-covering narration" enables a story to cover events over different periods. The "time relationship" between the narrative and the plot defines how the narrated time relates to the chronological plot. The "narrator", as an example of what Mahne calls "presentation", can be optional or constitutive, depending on the narrative structure. "Navigation alternatives", particularly relevant in interactive media such as hyperfiction or interactive data visualizations, enable the user to navigate through the information. In narrative genres, "spatial and physical representations" refer to how the physical world and its actors are visually presented in the narrative to create an immersive and comprehensible experience for the reader or viewer. In traditional literary works, such as novels or short stories, spatial representations involve the description of places, landscapes, and environments to create a scene. Body representations include the visual depiction of characters, their outward appearance, movements, and actions. In film and theatre, spatial and physical representations are conveyed through the visual staging of sets, backdrops, and the movements and interactions of actors. In comics and graphic narrative forms, panel layouts, the arrangement of images and the visualization of characters play a decisive role in conveying "representations of space" and the body (see original table by Mahne 2007, p. 128). In the context of data visualizations, the visual channel is served by the graphical representation of data, while the acoustic channel is less relevant, but can still be served with the help of digital media. The reception time varies depending on the complexity and design of the visualization. Time-covering narration is influenced by the possibility of presenting data in different time frames. Time relations between narrative and action can be explored in dynamic visualizations. About a traditional narrator, this is often missing as the focus is on visual elements, but it can be present in digital data stories. Navigation alternatives are relevant for enabling users to explore data in an interactive space. Spatial and physical representations can be interpreted as axes, dimensions, or graphical elements in data visualizations and are constitutive in this respect.

	Comic	Film	Audio play	Novel	Hyperfiction	Data visualizations
Visual channel						
Image	X	X	O	O	O	X
Text	X	(X)	O	X	X	X
Acoustic channel						optional
Music	O	X	X	O	X	optional
Word	O	X	X	O	X	optional
Sound	O	X	X	O	X	optional
Reception time	free	fixed	fixed	free	fixed/free	fixed/free
Time-overlayed narrative	O	X	possible	O	limited possible	O
Time relation	simultaneous	simultaneous	simultaneous,	later, earlier,	later, earlier,	simultaneous
Narration-action			later, earlier	simultaneous	simultaneous	later, earlier
Narrator	optional	optional	optional	constitutive	optional	optional
Navigation alternatives	optional	O	O	optional	constitutive	optional
Spatial and						
physical representations	constitutive	constitutive	optional	optional	optional	constitutive
	panel	screen			window	(online) dashboard
Representation spaces	panel sequence	shot	sound space	book page	title bar	mobile app
	page layout	montage			pop-ups	newspaper

Table 1: Tabular overview of diverse narrative genres according to Mahne (2007), adapted with an additional column for 'data visualizations' as a novel narrative genre

In this thesis, the acknowledgment of pathos as a phenomenon extending across different media prompts the recognition of its scholarly relevance in the realm of data visualizations. Consequently, it becomes imperative and appropriate to modify Mahne's (2007) table to accommodate this consideration. This adaptation seeks to investigate how pathos applies to data visualizations and aligns with broader transmedial narrative strategies. Nevertheless, the techniques employed to conceptualize data visualizations as a storytelling medium fall within the broader scope of the rhetoric of visualization (Liu et al. 2020, p. 2033). This positioning forms an interface that not only facilitates the integration of literary studies into this discourse but also warrants a reevaluation of its significance. The following chapters will explore the concept of rhetoric more broadly, before zooming into the specifics of visual rhetoric.

6 The rhetorical triangle: logos, ethos and pathos

Rhetoric is an important means to communicate in many different areas. It can be used to persuade, inform, and motivate audiences in a variety of contexts, such as in political speeches, advertising, and public relations. Rhetoric can also aid in creating effective written and oral communication, as well as in developing critical thinking skills. As individuals are presented with an increasing amount of data and its corresponding visualizations, the significance of rhetorical concepts in data visualization is also growing. The application of rhetoric is a useful means to enhance the comprehension, communication, and retention of data (Kostelnick 2008; Kostelnick 2016; Kostelnick & Hassett 2003, pp. 1-6; Muehlenhaus 2012). As visualizations have become established as a form of communication and their influence in society continues to grow, there is accordingly also the danger that this influence will be abused in some form and used for unethical purposes. Aristotle already understood this to be why a framework is needed to use rhetoric to persuade, rather than to deceive. He identified three modes of persuasion that aim to provide just that: logos (appeal to logic and reason), ethos (morality and credibility), and pathos (emotional appeal) (Campbell 2018, p. 17; Crampton 2001).

Aristotle is considered, among others, the founder of the theory of rhetoric, which he, in

turn, defines as a means of persuasion. He posits that rhetoric and dialectic share a common ground as they both deal with topics accessible to everybody, rather than specialized knowledge. He suggests that people naturally engage in both practices, either spontaneously or habitually, based on their inclinations. However, Aristotle contends that systematic engagement in these practices is achievable through observation and study. He criticizes contemporary rhetoric manuals for overemphasizing ancillary elements like emotions, neglecting the core of argumentation, such as enthymemes (meaning a rhetorical form of deduction) (Aristotle 2018, pp. 3/8). Certainly, Aristotle does not explicitly refer to data visualizations as a means of rhetoric but focuses on the means of persuasion at that time: the speaker. But also for the field of data visualizations, the three modes can be applicable and useful.

6.1 Logos

Logos is already highly valued in the visualization community and thus does not require too much detailed explanation. For logos, concepts like clarity (e.g. Tufte 1990, & 2006, & 2007), or the principle that data visualizations should be optimized for perception and the task they have to fulfill, play an important role. But to rhetoric, a certain kind of clarity is also relevant, just "as it is to poetry" (Aristotle 2018, p. 120); the factual information itself should enhance the persuasiveness of an argument in a speech (ibid.). In the realm of data visualization, logos refers to an appeal to logic and reason achieved through the use of cognitive approaches and clarity. This includes principles of design aimed at creating visualizations optimized for effective perception and task completion, as noted by Fayyad et al. (2002, p. 39). In this context, visual rhetoric is influenced by perceptual factors, and ignoring these factors can erode the user's trust and result in what Kostelnick & Hassett (2003) refer to as "rhetorical chaos". Therefore, the effective use of rhetoric is crucial in generating logos, as data visualizations should not only help readers understand data but also enable them to validate hypotheses and gain insights, as emphasized by Fisher & Meyer (2017, p. 6). Also, transparency is an essential element of logos. Studies in visual analytics have shown that transparency, including the ability to validate and verify model results, contributes to a higher level of trust in the model and

visualization (Dasgupta et al. 2016). Therefore, to increase logos in a visualization, it is crucial to create verifiable visualizations and highlight any uncertainties in the data space, as suggested by Dasgupta (2016). Visualizations that fail to acknowledge potential errors or limitations can generate uncertainty on the reader's side and negatively affect their decision-making process. To address this, designers can provide additional background information or explain how the data was collected and processed, such as through data provenance. Such an approach can also influence how much a reader perceives the presented information as trustworthy, as argued by Islam et al. (2008).

6.2 Ethos

The concept of ethos is a compendium of aspects that extend beyond the concept of classical ethics. Although ethics do play an important role in data visualizations (see e.g., Correll 2019), ethos in this context also includes the credibility of the source, adaptation of the visualization to the target group (social rhetoric), and aspects such as the possibility for users to change the display and explore it on an individual level (Kostelnick 2008; Correll 2019). Aristotle argues that proof through character occurs when a speaker delivers a speech in a manner that makes them trustworthy. He explains that people are more likely to trust individuals of good character, even in situations where certainty is uncertain and doubts persist (Aristotle 2018, p. 7). According to him, there are three factors contributing to a speaker's credibility: practical intelligence, virtue, and goodwill. Misleading statements and bad advice arise from false opinions due to ignorance, moral inhibitions, or intentional manipulation. Speakers possessing all three qualities are inherently credible (ibid., pp. 60-61). In the realm of data visualization, ethos encompasses factors like source credibility, tailoring visualizations for specific audiences (social rhetoric), and providing user interaction options for individual exploration and modification (Correll 2019; Kostelnick 2008). This highlights the importance of understanding how people interpret data. Research (e.g., Hullman & Diakopoulos 2011; Kim & DiSalvo 2010; D'Ignazio & Klein 2020) suggests that simply focusing on clarity is insufficient, necessitating the incorporation of socio-cultural aspects (Kostelnick 2008). The social environment in which people

grow up influences the way people deal with data visualizations and charts and how their sense-making process works (Kostelnick 2008; Suspitsyna 2013). Moreover, data visualizations are a product of social concepts and norms, and the definition of clarity therefore also differs from culture to culture and from social setting to social setting. This means that the information visualized has to be adapted to suit the purpose as well as the audience. Additionally, the context in which the visualization is displayed also has a crucial influence in this regard (Kostelnick 2008). Furthermore, ethos can be seen in the concept of trustworthiness. The issue of trust in social concepts is often described in phrases such as "honesty," "integrity," and "reliability" (van der Graaf et al. 2015). These terms could just as well describe ethos in its essence, although to date there are still no clear systematic results showing why and whom people trust in the first place (ibid.). Nevertheless, some studies show a relationship between trustworthiness and usability: Acemyan & Kortum (2012) came to the same conclusion in two different studies, namely "that the more usable systems were also the more trusted systems". In addition, there are observations indicating that the relationship between usability and trustworthiness exists across different domains within the technical domain, including information systems and e-health (Salanitri et al. 2015). However, the perceived trustworthiness in a certain type of technology depends on social and individual factors. In addition, the fact that whether a system contains a low or high level of usability can influence the trustworthiness of the system. Salanitri et al. (2015) found that "a low level of usability could compromise an individual's trust in their use of a technology" (ibid.).

6.3 Pathos

According to Aristotle, emotions play a significant role in persuasive communication, particularly in influencing the audience's judgment. He acknowledges the importance of evoking emotions in listeners to sway their perceptions and responses. However, he emphasizes the ethical responsibility of the speaker to use emotions judiciously and not to manipulate the audience unfairly (Aristotle 2018, pp. 3/60). The objective of pathos is that the audience is moved by the presented information not only to encounter what is said at the level of facts but to em-

pathize with the expressed concerns as if they were their own (Herding & Stumpfhaus 2004, pp. 10-13; Busch & Därmann 2007, pp. 7-24; Zumbusch 2010, pp. 12-20). This theory is also supported by neural studies that show when you have an empathetic response to someone else's experience, it "involve[s] the same brain tissue that's active when you yourself have that experience" (Bloom 2016, p. 62). The power of persuasion can be greatly amplified through the utilization of pathos, a rhetorical appeal that focuses on evoking favorable emotions in the audience and skillfully connecting these emotions to the purpose of the speech. Aristotle identified and categorized seven pairs of contrasting emotions that have the potential to be successfully stimulated. Those pairs are the following: anger/calmness, friendship/enmity, fear/confidence, shame/shamelessness, kindness/unkindness, pity/indignation, and envy/emulation. By harnessing these emotions, speakers possess a powerful tool to shape and guide the sentiments of their listeners, elevating their persuasive abilities beyond the mere content of their spoken words (di Carlo 2015, p. 25). Even though in science the aspects of ethos and logos receive a higher level of acceptance in the scientific context (Correll 2019), the emotional component also matters significantly, which is, however, currently becoming part of the scientific discussion as well, because an argument can only be persuasive if all three modes, logos, ethos, and pathos, are in balance. This gives rise to a new approach towards emotions in science, as studies have shown that emotions have an impact on how people process things. Emotions are associated with experience and thus part of the sense-making process that can mediate the cognitive outcomes of engagement with data visualizations (Dwyer et al. 2021; Kennedy & Hill 2018). Moreover, there is emerging criticism of classical cognitive approaches about product usability for neglecting the emotional level entirely and not including it in the understanding of the product experience that a user has (Rafaeli & Vilnai-Yavetz 2004). In this regard, emotions influence both actual and perceived experiences with products (Norman 2004; Jordan 2002, pp. 3-5). "Measurable emotional responses with products are apparent where attitudes, values, goals and expectations are coupled with usability and enjoyability" (Spillers 2004). This shows, that affect, an emotion or feeling triggered by external circumstances as well as mental processes within the body and describing the "ability to affect and be affected" (Shouse 2005), is linked

to attitudes, expectations and motivation in a way that influences how a product interaction is experienced (Rafaeli & Vilnai-Yavetz 2004). This implies that emotions have non-negligible influences on the design of a product, as well as on data visualizations, but furthermore, they affect cognitive processes and task performance (ibid.). One of the reasons for the importance of emotions about data is that they enable effective communication. By employing emotions, numbers, and data become translatable in such a way that people can make sense of them, understand them, and turn them into something tangible (Heath & Abrahams 2022). Similarly, the aspect of user experience has an emotional level: experiences are inherently linked to memories and thus also have a dynamic character, relating to people, and products but also changing over time and context (Forlizzi & Ford 2000). Still, it is particularly important to achieve a balance of all three types of persuasion. Wayne Booth refers to this as a "rhetorical balance among speakers, audience, and argument" (Booth 1963, p. 145). When talking about persuasion, attention is often drawn to the intense feeling of being moved on the recipient's side, a passive state from which one cannot escape. To acquire this state, it is necessary to actively resort to the element of pathos (Herding & Stumpfhaus 2004, pp. 10-12; Busch & Därmann 2007, pp. 7-24; Zumbusch 2010, pp. 7-21). Studies have shown that "the sense of hearing may be better than sight at detecting other people's emotions"; in addition, a speaker has more possibilities to transmit emotions to the recipients using his voice, tone, para-linguistic signals, etc. (Arana et al. 2020). That presents data visualizations, a primarily visual medium without a speaker, with challenges regarding the questions concerning how to convey emotion. Sarah Campbell has contributed pioneering work regarding the question of how pathos can be used as a rhetorical tool to convey more meaning to visualizations (Campbell 2018). She makes a point that strongly argues for empathetic emotions in data visualizations is the fact that visualizations are now increasingly important for scientific communication, data visualization creators are looking for ways to address the human way of thinking with visualizations and to some extent also be able to influence the emotions evoked in the audience (ibid.).

The previous explanations have considered the basic principles of rhetoric according to Aristotle whilst continuously establishing links to data visualizations. These connections have

created the context for the following detailed analysis – the specific characteristics of visual rhetoric.

7 Rhetoric of visuals

At this point, it is important to interrogate the relevance of rhetoric within the context of visualizations. Common perception might confine rhetoric to the domain of public orators or company representatives to mobilize their workforce. Yet, rhetoric underpins a comprehensive framework for effective communication transcending diverse milieus (Aristotle 2018, p. 3). This approach frequently employs meticulously constructed narratives, anecdotes, and exemplifications to captivate the audience and stimulate emotional responses. While this method of discourse may be construed as manipulative, it is not inherently so. Its applications can range from bewitching and enthralling to providing comfort, which is evident in romance, literature, and politics (Meyer 2017, p. 3). It is important to mention that persuasion stands distinct from deceit. Persuasion encompasses any message that aspires to mold, buttress, or modify the reactions of an audience. It is predicated upon convincing others through cogent arguments rather than misleading them with fallacious assertions (Stiff & Mongeau 2016, pp. 4-5)

Aristotelian philosophy defines rhetoric as the skill of making raw knowledge convincing, surpassing its disciplinary boundaries, and connecting it with previously communicated knowledge (Ueding 1976). To fulfill this objective, myriad rhetorical strategies exist, their explicit forms contingent upon the context of their application. Techniques pertinent to this treatise will be expounded upon in a subsequent chapter.

7.1 Rhetoric in the context of data visualizations

Rhetorical devices and conventions have the potential to establish an analytical framework that can significantly influence a user's comprehension of data visualizations (Hullmann & Diakopoulos 2011). Nevertheless, it is crucial to acknowledge that the primary aim of rhetoric is the facilitation of effective communication. Consequently, data visualizations transcend the

boundaries of mere technical artifacts; they also function as rhetorical entities. Any object that reflects decisions regarding the selection and portrayal of reality inherently possesses a rhetorical nature. In this regard, the ancient Greek characterization of rhetoric as "the ability to discern, in any given instance, the available means of persuasion" (D'Ignazio & Klein 2020) remains applicable. This concept is reflected in every design decision underpinning data visualization. Even visualizations that appear neutral retain the capacity for persuasion, and not recognizing their rhetorical element can result in adverse consequences. The acknowledgment of the role of emotion in data visualization is becoming more important, as it wields significant power in transmitting a message. Emotions can profoundly affect viewers, eliciting empathy, comprehension, and motivation. For example, Periscopic's "U.S. Gun Killings in 2018" graphic, wherein emotion is employed to produce a memorable impact. This visualization shows a form of an interactive line chart. It presents a meticulous analysis of gun homicides in the U.S. for that year. Drawing on the FBI's Supplementary Homicide Report, it metaphorically uses bullets to represent the victims and provides detailed data on victims, perpetrators, weapons, circumstances, and crime locations, with a focus on firearm-related incidents. It incorporates considerations of ethnicity and race, highlighting narratives specific to the Latinx community. By counting "years stolen" and drawing attention to potential lives unlived, the visualization accentuates themes of loss, sorrow, and bereavement. The depiction of stolen years through gray lines, along with the utilization of animation and timing, amplifies the counting effect and enhances the sense of loss, thus deeply resonating with the viewer's emotional state. It is noteworthy that the interplay of emotion and visual simplicity can act synergistically to optimize the impact, as illustrated by the Periscopic visualization. By selecting and leveraging visual elements such as color, form, and motion, a message is rendered more compelling and indelible. Understanding the rhetorical dimension of data visualization and the potential influence of emotions is essential for conveying the intended narrative to the audience. Accordingly, data visualizations intrinsically entail a rhetorical aspect that warrants consideration. The selections made in data representation embody determinations about which information to emphasize and how to contextualize it, thereby shaping the viewer's perspective (D'Ignazio & Klein 2020). By recognizing and harnessing the

rhetorical aspects of data visualization, and by comprehending the potential ramifications of emotions, it is feasible to deliver a message that captivates the audience and promotes valuable insights.

7.1.1 The emergence of visual rhetoric

The origins of visual rhetoric can arguably be traced to Lord Kaims's "The Elements of Criticism" (1762), which layed a philosophical and aesthetic groundwork for appraising expressive art across various mediums, including words, visuals, and sound (Bevilacqua 1971). Since the 1960s, "The Elements of Criticism" has not been subjected to comprehensive analysis or discussion, despite its former significance in apprehending the evolution of rhetoric (Manolescu 2003). It is even credited as the starting point for visual rhetoric, that is, the inclusion of visual arts within rhetorical theory. In the United States during the first half of the 20^{th} century, the study of rhetoric was predominantly concentrated on oral communication, guided by classical rhetoric principles. This focus was firmly on the verbal dimension, with visual elements receiving scant attention. Contrarily, the latter half of the 20^{th} century marked a paradigm shift. The rise of television brought visual persuasion to the forefront. Political movements began exploiting "photo opportunities," and politicians became skilled in "image management". Philosopher Kenneth Burke's redefinition of rhetoric extended its reach to encompass nonverbal forms of communication, influencing a spectrum of academic fields. While semiotics have long considered pictures as symbols, there has been a tendency to label them as "iconic" or "indexical" signs, implying a natural connection. In contrast, a rhetorical perspective assumes that symbols in discourse are "conventional," meaning they rely on social agreement rather than inherent resemblance or cause, making them arbitrary (Kenney & Scott 2003). Such rhetoric, be it verbal or visual, not only reflects but also fortifies communal values and beliefs. Images, in particular, have the power to make people feel like they are experiencing events firsthand, confirming existing beliefs (Kjeldsen 2021).

7.1.2 Data visualization is communication

Rhetoric constitutes an aspect of communication across various domains (Aristotle 2018, p. 3). Consequently, narrative data visualizations maintain a close relationship with communicative data visualizations, with no clear differentiation between the two. When data visualization employs narrative methods to craft a story, it inherently serves a communicative purpose (Dahlstrom 2014). Communicative data visualizations often use various techniques, including persuasive and rhetorical elements, to achieve a particular effect and effectively convey the message of a (scientific) story (Hullman & Diakopoulos 2011, p. 2231). Nonetheless, there exists a dilemma in that the criteria for a communicative data visualization to be deemed successful and effective are nebulous, as are methods for assessing the "success" of such communication. Each visualization has unique objectives, and therefore, there is no single goal that unifies all communicative data visualizations. The background with which the visualization was created and the context in which it is used also determine what is considered successful or unsuccessful in a particular case (Crampton 2001, p. 236; Hung & Parsons 2018). In addition to narrative methods, exploratory and dialectical approaches are frequently utilized in data visualizations, fostering user interaction with the data (Hullman & Diakopoulos 2011, p. 2231). Consequently, the audience transitions from passive recipients to active contributors, empowered to alter both the presentation and the data. This evolution in user engagement was facilitated by technological advancements. Historically, the rhetorical processing of data or stories was confined to oral or written mediums However, the emergence of the screen, an interactive medium, has transformed how communication takes place (Kostelnick 2008; Firat et al. 2022).

7.2 Rhetoric in data visualization: contemporary approaches

As already mentioned, rhetoric approaches in data visualizations get increasing levels of attention. In 2021, Pflaeging & Stöckl examined the rhetorical impact resulting from the fusion of layout, typography, and color in magazine design, emphasizing the crucial role of visual structure as it underscores and provides guidance, signaling what is significant on a magazine

page and what is not (ibid.). Hullman & Diakopolous (2011) probably would locate this at the editorial layers, consisting of a visual representation of data, annotations (e.g., visual, textual, graphic, or social), and interactivity. However, she has also identified the following specific classes of rhetorical devices for visualizations.

- *Information Access Rhetoric*, including omission to simplify complex ideas, using metonymy to represent parts of a whole for simplification, using averaging and aggregation.
- *Provenance Rhetoric*, including signaling transparency and trustworthiness by linking data sources, effectively representing uncertainty, and providing information about the visualization's designer.
- *Mapping Rhetoric*, including: obscuring through noise and sizing changes, employing visual metaphors and metonymy for implicit meanings, as well as utilizing contrast, classification, and redundancy methods to enhance communication in data visualizations.
- *Linguistic-based Rhetoric*, including typographic emphases like font bolding, and irony via rhetorical questions, showing similarity through analogies and metaphoric statements, along with individualization methods such as direct address and framing from an individual perspective.
- *Procedural Rhetoric*, including rule-based representations and interactive functions for conveying meanings, anchoring techniques like default views, fixed comparisons, or spatial ordering, interactive methods such as individual filtering options through search bars or menu options (Hullman & Diakopoulos 2011).

In addition to Hullman's classifications, other rhetorical approaches are serving as illustrative examples. The rhetorical concept of the sublime for instance, aims to captivate audiences through evocative grandeur. Immanuel Kant reinterpreted the sublime as an emotional human response to the magnificence encountered in art or nature, foregrounding the sensual experience. This notion aligns with data visualizations that engage viewers visually and then deepen

understanding by emphasizing emotions and senses in the acquisition of knowledge. "Sometimes it is the very fact that they present reality as understandable and predictable through data models that make data visualizations so convincing" (Rettberg 2020, p. 45). Another relatively new form of rhetoric in this context is speculative visualization. Emerging from speculative design, this approach aims to reveal hidden social issues in everyday life by engaging in diverse design practices, including participatory workshops and conceptual proposals. Within this realm, speculative visualization emerges as a subset that employs visual methods to stimulate reflection, uniting multiple disciplines such as artistry, aesthetics, scientific data analysis, and a humanitarian perspective (Kim & DiSalvo 2010). There is a correlation between rhetoric and design, intricately intertwined with aesthetics. The subsequent discussion will elucidate the various design approaches possible and explore the interconnectedness of rhetoric, aesthetics, and design.

7.3 Design approaches as part of rhetoric

A profound interconnectedness exists among rhetoric, aesthetics, and design. Although historically, aesthetics have often played a subservient role in functionality within the design process, its significance is undeniable. The principle "form follows function" highlights that notion, while aesthetics remains not the primary concern, it still plays an integral role in discourse, accentuating the value of utility, intended use, and contextual relevance (Bürdek 2005, pp. 17-18; Knape 2021). Aesthetics dictates the core tenets of visual allure and beauty, which are seamlessly woven into the design process. At its core, design is the tangible application of aesthetic principles to create visually engaging artifacts, spaces, or communication methods. In design methodology, the focus is predominantly on the expressive elements during the conceptualization stage, ultimately shaping objects and structures. The term "design" derives from the Latin "designare," originally meaning "to designate" which, over time, morphed to imply "to draft" in the 15^{th} century (Knape 2021). As in rhetoric, where language and presentation are paramount for persuasion, design serves as a visual form of rhetoric, using aesthetics to convey messages effectively and evoke specific responses. In parallel to this argumentation, Norman

(2013) presented a framework comprising three different types of design: industrial, interaction, and experience design. Each type's focal point differs based on its objective: "industrial designers emphasizing form and material," in other words, optimization of functionality, "interactive designers emphasizing understandability and usability," the attempt to improve the understanding of what can be done with the design, and "experience designers emphasizing the emotional impact," which means a holistic experience for the user, a complete journey (Norman 2013, p. 5). Although these are seen as distinct areas, they also represent the three layers present in the UX hierarchy of needs. Such models can vary with the source and research area, yet their composition remains consistent: the foundation is "functionality," followed by "usability," and "aesthetics," which is also referred to as an "enjoyable experience" and thus constitutes the apex (ibid. p. 5). Figure 1 is an example of such a UX hierarchy of needs.

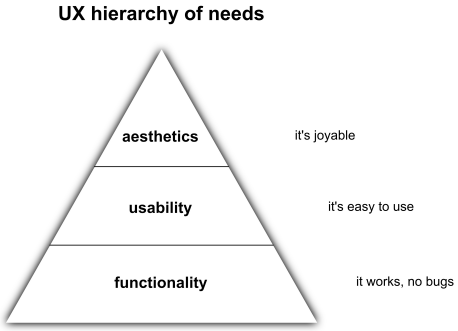

Figure 1: UX hierarchy of needs, adapted from Michael Heraghty (2011)

There is an apparent reference to software ergonomics because if computer applications show a lack of usability, i.e. do not function properly, the effectiveness and efficiency of the work of those who have to deal with such software is reduced as a consequence. This not only leads to poor work results but also has an impact on user satisfaction. To counteract this, the three aspects of effectiveness, efficiency, and satisfaction were given a higher priority in the field of software ergonomics by elevating them to the three main factors of usability (Herczeg 2018 p. 10). Interestingly, the emotional response of the user is a main component in the field of software ergonomics ("satisfaction"), as well as in the UX hierarchy of needs ("it's joyable"). Similar to how ethos, logos, and pathos must be well-balanced to achieve persuasive efficacy,

the components within the UX hierarchy of needs must be collectively integrated into a holistic design strategy that fulfills all hierarchical echelons. "Designers need to make things that satisfy people's needs, in terms of function, in terms of being understandable and usable, and in terms of their ability to deliver emotional satisfaction" (Norman 2013, p. 293).

A congruence can be drawn between Aristotle's methods of persuasion and the UX hierarchy of needs, indicating substantial parallels, exemplified in Figure 2. Logos, denoting logic, coincides with functionality in UX design, emphasizing explicit and purposeful design. Ethos, centered on credibility and ethics, parallels usability, reinforcing user-centricity, and reliability, and trustworthiness. Pathos, focusing on emotions, corresponds to aesthetics, aspiring to create emotionally engaging experiences. In both realms, achieving balance and integration is crucial: whether it's harmonizing ethos, logos, and pathos for persuasive communication, or seamlessly blending functionality, usability, and aesthetics in UX design to forge compelling and persuasive user experiences. The potential for successful persuasion through rhetoric exists, as a design approach to appeal to an audience's rational and emotional side is supported by the so-called dual-process theories. In psychology, dual-process theories provide explanations of how thinking can occur in two different ways or as a result of two distinct processes. These processes often comprise an implicit, unconscious process and an explicit, conscious process (see Kahneman 2012). Among these theories, the most relevant for design, according to Knape (2021), are:

- **Dual coding theory:** Designers should mix different codes, like languages and images, to enhance audience processing (ibid.). Employing a combination of visuals and written content enables people to access information through text, visuals, or a combination of both (Vavra et al. 2011).

- **Dual system theory of cognitive processing:** To engage both rapid and reflective thinking, designers can use strategies such as connotations, associations, and metaphors (Knape 2021). As users become more comfortable with digital tools, design principles tend to favor simpler and standardized styles that work well across different platforms, like web,

tablets, and mobile devices. Despite this, many widely used visual elements, like icons and sliders, still incorporate real-world metaphors for their effective usability.

- **Cognitive psychological model of persuasion:** Design choices can lead to specific cognitive responses, emphasizing the importance of how information is shaped and organized in design (ibid.). This can be connected to the design principle of simplicity applicable to (interactive) visualizations which involves implementing progressive disclosure, where elements are concealed until the moment they become necessary for the user (Knape 2021).

The combination of all these concepts provides a foundation for effective communication, which is needed to deliver complex information today, especially when facing challenges like COVID-19 or climate change. To play a role in societal decision-making, science depends on effective communication. Researchers need to present their findings in the best way possible and make them understandable, plausible, and engaging to the general public (Susanka & Kramer 2021).

7.3.1 The interplay of rhetoric, aesthetics, and data visualization

The previous section has shown, that aesthetics and rhetoric should not be seen as antithetical to one another. Instead, they represent two distinct discourses, each offering unique principles and frameworks with which to analyze and comprehend objects. Aesthetics is primarily concerned with notions of beauty and pleasure. From a Kantian perspective, it invites one to admire and probe the beauty and meaning inherent in creation. Rhetoric, in contrast, is the art of persuasion: "Considering the rhetoric of the work focuses on its manipulations [...], perhaps as a function of where those manipulative designs came from and how they are embedded in the work" (Gorbman 2004, p. 14). The theory of rhetoric, however, follows a well-defined objective: to engender persuasive communication. The stages involved in producing a speech are namely: Inventio (contemplating the contents of argumentation and emotional means), dispositio (drafting an outline), elocutio (employing stylistic techniques and linguistic finesse, along

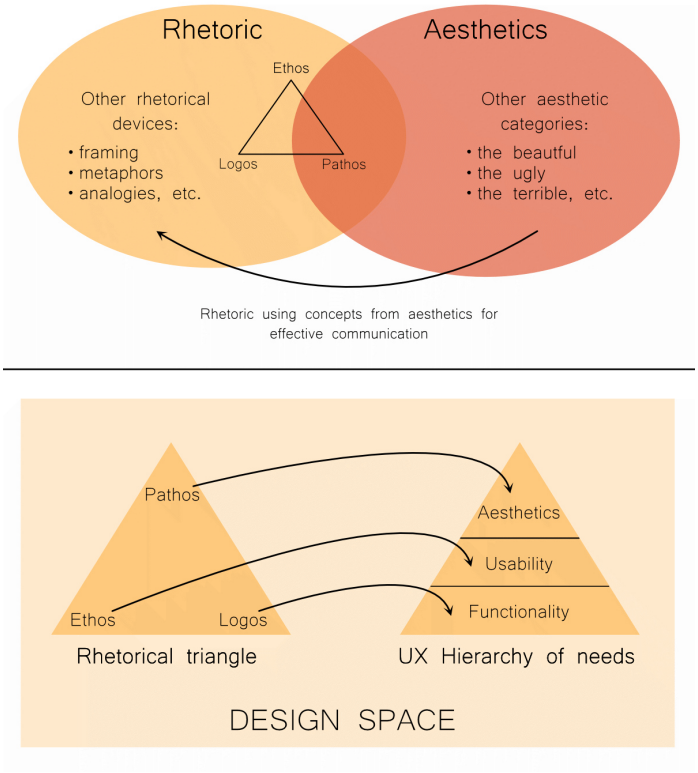

Figure 2: The illustration shows the interplay between rhetoric and aesthetics on the top. It is a complex connection, whereas rhetoric frequently makes use of concepts from aesthetics, making them rhetorical stylistic devices in communication or supporting them. In the middle is the rhetorical triangle coined by Aristotle for persuasive communication. On the bottom, the parallels between the UX hierarchy of needs (adapted from Heraghty 2011) and the rhetorical triangle are visualized.

with production aesthetics), memoria (committing the speech to memory), and actio (the delivery of the speech itself) (Schirren 2008). The synergy between aesthetics and rhetoric largely arises during elocutio, specifically through the use of stylistic elements and linguistic composition. By using aesthetic principles in rhetoric, aesthetics is given a purpose, serving a specific goal, aimed at achieving a specific intent. Rhetoric, thus, is a pragmatic instrument that can be utilized by speakers and, in contemporary settings, designers. It encompasses tangible techniques and stylistic measures that can be intentionally applied. Conversely, aesthetics liberates from the constraints of practical exigencies, permitting a free space for self-reflection within the temporal dynamics of action. Aesthetics is marked by creative interpretation as well as rhetorical application (Rüsen 2005). To put it differently, rhetoricians leverage aesthetic principles to enhance the persuasiveness of their arguments, assigning a purpose to aesthetics by incorporating them into their communication. Interesting enough, the tension between rhetoric and aesthetics in design was at the center of a dispute between Richard Buchanan and Klaus Krippendorff in 1985. Buchanan contended that the emotional resonance of a designed object, which he described as the "rhetoric of the object," has the power to sway human actions (Knape 2021, p. 10). To him, design functioned as a vehicle of persuasive influence. Krippendorff countered this view, proposing that the influence of a designed object was fundamentally aesthetic in nature, stemming from the objects' inherent aesthetic qualities, unrelated to persuasive rhetoric. This debate casts light on the enduring disparities between the persuasive might of rhetoric and the aesthetic influence extant within design objects, with each contributing distinctively to the way individuals perceive and interact with these objects (ibid.). This connection between rhetoric and design is a topic that is subject to occasional discussion and theorizing. Like rhetoric, design can possess a persuasive element, as it frequently seeks to shape people's thoughts, beliefs, perceptions, and attitudes (Susanka & Kramer 2021). In this context, the role of emotions becomes particularly salient. Contemporary cognitive psychology accentuates the symbiotic relationship between reason and emotion. This idea bolsters the view held within theories of rhetoric that cognition and affect are intertwined, underscoring the correlation among rationality, emotions, and trust as encapsulated by logos, pathos, and ethos (Kjeldsen 2021).

In the following subsection, the utilization of aesthetics by visual design will be examined. The impact of design choices on the overall visual appeal, considering elements such as form and color, will be explored. An understanding of how aesthetics influences visual design decisions will be sought through this analysis.

7.4 Visual design: approaching convincing aesthetics

Design research meticulously examines the potential for knowledge dissemination through design. When visualizations are seen as a kind of "technology probe" (Meyer & Dykes 2019, p. 89), it creates the opportunity to learn more about the connection between people and data that goes beyond just knowing about the visualization itself. After all, "design study researchers construct knowledge subjectively through reflective critical reasoning based upon experience and evidence established through the study, and against a backdrop of existing knowledge" (ibid. p. 91). Thus, design is a manifestation of the designer's subjective perception and may not always fulfill the requirement of objectivity in data and its visualization—a skepticism previously expressed by Correll (2019). This raises the question: is such objectivity necessary?

To approach this question, it is necessary to briefly talk about the philosophical position within computer science and also the data visualization community. Positivism is the dominant philosophical position, which assumes that reality can be known and represented objectively. Collecting data has one goal, which is to provide a unique result that is representative of this singular reality. Compared to the natural sciences, the social sciences and humanities tend to criticize such positivistic approaches and instead adopt a relativistic position that sees reality not as singular but as diverse and subjective. Meyer & Dykes (2019) also state that relativistic viewpoints should also be recognized in data visualization research and that the knowledge acquired by researchers should be seen as socially constructed. They "argue that the visualization community is missing a broadly shared understanding of how research emerging from these very different philosophical positions is undertaken with rigor" (ibid., p. 88). Focusing on data visualization techniques, a novel approach to "make feels with data vis" (Muth 2016) involves the strategic use of color. This tactic is exemplified in "U.S. Gun Killings in 2018" (Periscopic

2018), "The Fallen of World War II" (Halloran et al. n.d.), and "Out of Sight, Out of Mind" (Pitch-Interactive n.d.). Similar to "U.S. Gun Killings in 2018," which was already mentioned before, "The Fallen of World War II," is an interactive, data-driven documentary, that visualizes the exorbitant human cost of the Second World War and the subsequent decline in battle fatalities. Its 15-minute narrative employs cinematic techniques to impart a new and profound perspective on this epoch. The third, "Out of Sight, Out of Mind" by Pitch-Interactive, graphically chronicles drone strike data from 2004 to 2013, aiming to foster awareness and catalyze contemplation on drone warfare. It uses visual engagement as a tool to prompt introspection on the repercussions of such strikes. A salient element that unites these visualizations is their poignant use of colors, which can significantly influence the emotional response elicited (Muth 2016; Samsel et al. 2018). Given that all three examples center on the somber theme of violent deaths, their swathe of colors serves as a simple conduit for empathy. However, it is essential to recognize that the primary intent of data visualization takes precedence, influencing which design techniques to employ. A study by Matson et al. (2018) on affective data visualizations suggests that while changing fonts and graph scales doesn't significantly affect emotional responses, altering colors does have a notable statistical impact. However, research is still needed to ascertain which specific colors, influenced by the cultural contexts of viewers, more effectively evoke emotional reactions (Matson et al. 2018). This is exemplified in Figure 5, where employing colors achieves heightened emotional engagement with the visual representation.

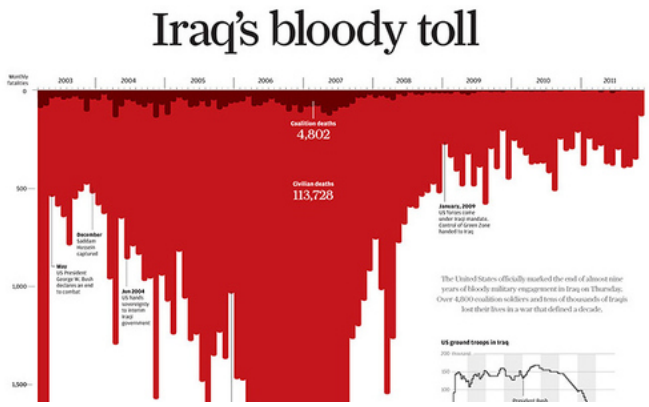

Figure 3: An extract of the visualization "Iraq's bloody toll" by Simon Scarr (n.d.)

7.4.1 Ethos & pathos: a continuous discussion in science

Although there are already experts who are convinced that data has to be enriched with emotions to achieve an effect (e.g. Bertini 2017; Heath & Starr 2022; Kostelnick 2008; Kostelnick 2016), the question of emotions in data visualizations remains controversial. The role of logos (reason) is uncontested; however, ethos (ethical concern) has been recognized as a significant consideration. Only in recent times has the ethical dimension of data visualizations become a topic of scholarly attention (Correll 2019). Previously, the prevailing viewpoint was that data, and by extension data visualizations, were apolitical and ethically neutral, grounded in the belief in the objectivity of data (Boehnert 2016; Correll 2019). Subsequently, this led to the assumption that there were no moral obligations for the creators of data visualizations in terms of collecting and visualizing data. This assumption that data visualizations are a pure, neutral presentation of objective facts is seen as very dangerous by Michael Correll. He states that people involved in creating data visualizations also have moral obligations and are sometimes confronted with ethical dilemmas (Correll 2019). Recently, there has been an increased awareness in the visualization community that a critical perspective on visualizations is needed to expose underlying power relations and to show that even seemingly objective data sets can be used to favor certain points of view (Kennedy et al. 2016). At the same time, many visualization workers believe that individualizing and emotionalizing data visualizations can lead to a better understanding of the data because it makes it more accessible to the audience (Campbell 2018; Kennedy et al. 2016). Against this argument, the principle of clarity stands as an indispensable element of comprehensibility in data visualizations, harmonizing with Tufte's minimalist paradigm (Kostelnick 2008). It is a challenge to deviate from these established principles and shift the emphasis from minimalism to a balanced trifecta of pathos, ethos, and logos. From a rhetorical perspective, it is also necessary to ask what exactly is understood by clarity, for this concept is far more complex, involving many more facets, than it did 50 years ago (ibid.). Clarity, as per Tufte, is often associated with a high data-ink ratio and immaculate design, yet such simplifications can mask the inherent complexity of the data, presenting an image that is deceptively neater than reality (Kennedy et al. 2016). Therefore, invoking the rhetorical strategy of pathos in presenting intri-

cate datasets might be advantageous: "Clarity may initially depend on pathos appeals that draw readers into the display by stirring their emotions" (Kostelnick 2008, p. 120). Nonetheless, this must be carefully balanced with ethical considerations to shield the audience from malpractice (ibid.). Furthermore, the ongoing discourse on whether data visualizations inherently do 'good' or 'bad' (Kennedy & Engebretsen 2020, p. 20) underscores the subjective nature of data visualizations, which stands in stark contrast to the presumed objectivity of the data they represent. Yet, within this framework, the role of pathos is scrutinized with skepticism and continues to elicit varied and often contradictory opinions.

8 The human aspect in visual design

The significance of the human element in visual design cannot be overstated, for it is the very aspect that allows people to forge connections beyond mere statistics (Harris 2015; Slovic 2007). Paul Slovic (2007) designates this as the effect of "psychophysical numbing." Drawing on his expertise as a data journalist, Jacob Harris, a Senior Software Architect with the New York Times, proposes three specific techniques used by data journalists to provide data graphics with empathetic aspects, in order "to anchor their graphics in empathy and connect readers to the dots in a graphic" (Campbell 2018, p. 29). Those techniques are: "near and far," "putting people first," and "wee people" (ibid.). The latter is a pictorial graphic that takes the form of human silhouettes; also called Isotypes (Harris 2015). Research has shown that such pictographic representations play a role in aiding audiences to better grasp the concepts illustrated, forging a "connection between abstract data and actual people" (Boy et al. 2017, p. 5462); they also contribute to enhancing the recall value of the message (ibid.). The "near and far" technique denotes presenting data at both individual (micro) and collective (macro) levels, supporting readers in identifying with the "dots." The "putting people first" method mirrors the approach of making individuals behind the data more visible, akin to that presented in the aforementioned study (Harris 2015). Another way to humanize data visualization is to use so-called "wee people" or anthropographics, this approach encompasses pictorial graphics represented by human silhou-

ettes. Utilization of pictographic representations has been evidenced to assist audiences in better comprehending the presented concepts, forging a "connection between abstract data and actual people," whilst simultaneously enhancing message memorability (Boy et al. 2017; Morais et al. 2021). An example of this approach is shown in a Washington Post article "An eye for an eye?" (by Berkowitz et al. 2014), which shows pictograms to display the fluctuating numbers of executions in the U.S. from 1976 (its reinstatement) to 2014. These wee people, differentiated by color based on ancestry (white, black, Hispanic, and other), demonstrated the concept effectively. Nevertheless, the application of this technique might not be universally appropriate for all topics and every visualization (Harris 2015). However, using human-shaped forms to display human beings, is not a completely new approach. The concept was introduced by Brinton in 1914 and later further elaborated by Otto Neurath (and called "Isotypes"). Alberto Cairo, however, "doubts the effectiveness of wee people to foster emotion", but is quite convinced that the option for the recipients to zoom into one dot within the visualization and thus "showing the mass as individuals", can have a positive effect on evoking empathetic emotions (Campbell 2018, pp. 29-30).

8.1 Emotional framing

Another way to humanize design is by using the concept of framing. Framing, akin to pathos, is a rhetorical technique that affects the persuasive power of a message based on how the content is articulated and the context in which it is presented (Seo & Park 2019). Framing itself is not synthetic; rather, it delineates how individuals generate thoughts and knowledge. "Every word is defined through the frames it neurally activates" (Lakoff 2010, p. 71), and is embedded within a neural system. Consequently, a solitary word can be sufficient to trigger not just the frame in which the word is located but also the entire system associated with it (ibid.). A study by Kong et al. (2018) tests the effect that titles and headlines of data visualizations have on the perceived central message. There is a "lack of awareness of the potential bias introduced by the title" (ibid., p. 10) because the confidence in the objectivity of facts and statistics is often so strong that any framing by the title goes unnoticed. Nevertheless, the

study shows that even the presence of a trivial graph can amplify the persuasiveness of the information presented (ibid.). This study is supported by other research, indicating that negative emotions facilitate the systematic processing of information, whereas positive emotions may impede it. Conversely, positive emotions can enhance flexibility, inclusiveness, efficiency, as well as receptivity to the information provided (Avry et al. 2020). This implies that both the design of a visualization and its context, as well as their interaction with contextual frames such as illustrations, play a role in how the visualization is perceived. Hence, framing can serve to represent data more convincingly; however, if misused, it can lead to a distorted perception of statistics. Therefore, when aiming to convey complex issues to a broad audience – as data visualizations typically intend – it is essential to employ framing to structure such messages effectively. This is because framing influences not only how much knowledge observers gain from the communicated messages, but also whether they are heeded at all and whether they are evaluated as positive or negative (Xu et al. 2015). In essence, framing is a technique that deliberately shapes the framework around a message to achieve a certain goal.

Daniel Kahneman describes framing as a process wherein the interpretation of a message is influenced not only by the content itself but also by the preconstructed context (Zer-Aviv 2015). Kahneman perceives framing as a means of instilling meaning, which remains subject to alteration with shifts in context, even when the core content is unaltered: "The fact that logically equivalent statements evoke different reactions makes it impossible for humans to be as reliably rational as Econs" (Kahneman 2012, p. 353). Here, "Econs" is a term borrowed from behavioral economics, signifying hypothetical individuals who are assumed to thoroughly deliberate upon the costs and benefits of various choices before decision-making. An "Econ", moreover, is characterized as analytical, reflective, and well-versed in areas such as probability theory and rational optimization – traits often far removed from the capacities of actual human beings (Niederjohn & Holder 2019). Kahneman goes on to identify two distinct systems that underpin human thought: system 1 (fast thinking), associated with rapid, pattern-recognizing cognition, and system 2 (slow thinking), denoting a slower, more deliberative mode of thinking. These systems, when influenced by "emotional framing," can come to different conclusions to

the same question (Kahneman 2012). Emotions are pivotal in this context because, as Lakoff (2010) asserts, without emotions, rational thinking is untenable, because emotions only contribute meaning to an issue – and only in this way do "like" and "not-like" acquire meaning, which in turn leads to meaningful decisions (Lakoff 2010). The impact of framing on human behavior has been substantiated through numerous empirical studies. Wang et al. (2022) examined the influence of various framing strategies, namely scale framing and benefit framing, on energy-conservation behaviors. Their findings highlight the criticality of the message itself, an effective strategy to convey information is paramount. Additionally, they recognized that it is more effective to reward positive behavior than to try to change current behavior and attitudes. In other words, an advertisement that promotes energy-saving attitudes has no significant effect on the corresponding behavior of recipients (ibid.). There is additional research that supports these findings, demonstrating how personal experiences linked with data can shape people's decision-making processes. This phenomenon is highly individualistic, rendering it challenging to generalize to broader populations (Peck et al. 2019). The emotional framing of a message also influences its perceived credibility and whether it is questioned or not. Research suggests that the nature of conveyed emotions – positive or negative – is pivotal; individuals in positive emotional states tend to engage in heuristic, less cognitively demanding information-processing strategies. Conversely, individuals in negative emotional states are more inclined towards analytical, detail-oriented, and cognitively intensive strategies (Li et al. 2022). One example of emotional framing within data visualizations is, again, "U.S. Gun Killings in 2018" (Periscopic 2018). The arcs, which are also visualized as gunshots, are accompanied by the names of the victims, making the entire graphic more than just a statistic made up of numbers. At the same time, the juxtaposition of lived time to lost time, that is the time that the victims would have statistically still lived, creates an empathetic feeling on the part of the recipients. This empathetic and poetic design is not least the reason for its effectiveness and expressiveness (Zer-Aviv 2015).

8.2 Personalization by using interactivity

Personalization is a big part of discussions about pathos and rhetoric. It is supposed to facilitate tailored connections between content and people. Technology can enable a personalized approach through the integration of interactivity, providing an individual micro- and macro-view. Slovic & Slovic call this method "telescoping", which "will bring to life a large, subtle topic without distorting or obscuring the general subject" (Slovic & Slovic 2015a, p. 82). Rawlins & Wilson (2014) recognize that as the degree of interactivity changes, so does the role of the user: "Each user is not simply a recipient of information, but is potentially a creator of meaning" (Rawlins & Wilson 2014, p. 316). This leads back to the concept of zooming in and out of a data visualization, or micro- and macro-view. Those are two levels within a visualization that can be addressed as needed with the help of interactivity. Macro-view refers to the big picture and micro-view provides some kind of deep dive into the details of the visualized data. Figure 4 is an excellent example of a visualization that creates multiple layers within one image using the zoom effect. Chris Jordan has created several such images that in macro view show one large image, but by clicking on it, it becomes clear that it is made up of many smaller images, some of which may have a different message than the large image and hence is one possibility to create pathos.

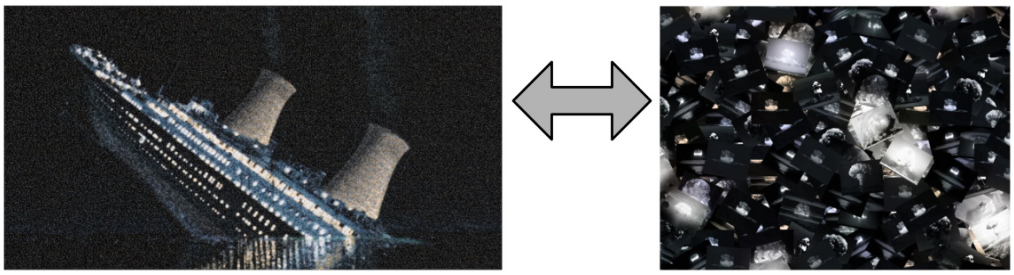

Figure 4: This visualization by Chris Jordan (2006)is an animated image where clicking on the large image (in this case a sinking boat) triggers a zoom effect and the image gets bigger and bigger until it becomes apparent that the ship is composed of many small images of atomic mushrooms

Thus, users can see the data in a macro-view, which would satisfy Edward Tufte's claim

for data visualizations, but also in a micro-view, which again serves for a better connection of place (Kostelnick 2016). Moreover, interactive data visualizations extend their utility through features such as display customization, allowing choices over chart types, graphic styles, background colors, etc., (Rawlins & Wilson 2014), as well as the ability to select the subject matter being visualized (Campbell & Offenhuber 2019). In terms of eliciting empathetic responses, interactive displays enhance the potential for engaging the target audience on an individual level, thereby drawing them closer to the curated data, which promotes a deeper, more personal engagement (Kostelnick 2016). Kostelnick argues that this effect of personalization is realized through the following components:

- enabling users to shape and scale data displays to meet their needs;
- affording interaction with other users and designers;
- visualizing fluid (often real-time) data, heightening the immediacy of the data; and
- encouraging self-expression, including the visualization of personal data (ibid.).

Through the implementation of various techniques, Kostelnick notes that data designers can potentially evoke empathetic responses in recipients, fostering not only enthusiasm, but also increased engagement and comprehension. Consequently, Kostelnick advocates for the acceptance and strategic management of emotion in data design, emphasizing its constructive role rather than discouraging or disregarding it (Kostelnick 2016).

8.3 How individual can it be?

As interactivity expands, the potential for personalized data visualization increases. While this development positively influences techniques aimed at eliciting empathetic responses, the consideration of individuality becomes paramount in comprehending visualized data. Achieving a deep understanding of visualized data requires not only 'statistical skills and confident numeracy" (Kennedy & Hill 2018, p. 381), but also an awareness of visual parameters and a cultivated sensitivity. Kennedy critiques the prevalent oversight of individual socio-cultural backgrounds

in studies focusing on emotions in data visualizations, emphasizing the influence of these backgrounds on perception and subsequent emotional reactions. Notably, Kennedy's focus group revealed a significant decline in engagement with data visualizations when participants felt ill-equipped to interpret the information, resulting in feelings of confusion and dislike (ibid.). To mitigate such negative outcomes, the adoption of a human-centered design (HCD) methodology for data visualizations proves advantageous. Human-centered design, which addresses users' needs, aims to prevent frustration with the design. Contrary to historical misconceptions that viewed emotions as obstacles to logical reasoning, contemporary research, as articulated by Norman (2004), recognizes their significance in daily life and their utility in evaluating circumstances. Norman contends that "attractive things work better" (p. 17), emphasizing the positive impact of appealing design on user interaction.

9 Emotion, affect, pathos

Emotion and affect constitute integral components in our comprehension of the human condition. While often utilized as synonyms, they embody distinct connotations and represent varying tiers of subjective experience. Emotion refers to particular feelings or mental states that are conscious and deliberate, whereas affect refers to a wider spectrum of subjective phenomena, encompassing moods, feelings, and physiological responses. Comprehending the differentiation between emotion and affect is important for a better understanding of human experiences, pervasive not only in everyday life but also within the realm of scholarly and theoretical discourse. Affect theory, for example, has become a significant theoretical framework for understanding the relationship between bodies and their environment by highlighting the gap between how the body feels and how people process those feelings. This gap is seen as a productive site for intellectual, economic, technological, and political investment. However, the gap between affect and emotion is not just an abstract concept, but a fundamentally political problem. (White 2017). Narratives striving to close the gap between affect and emotion find their roots in various analytical, ethical, religious, and scientific frameworks. The self-perception and worldview of

individuals and collectives are influenced by such narratives. By looking into the complexities of human experience and acknowledging the distinction between emotion and affect, a more intricate and critical lens is provided through which the molding and transformation of subjective experience can be observed. Such insight can be used to guide personal and political engagements, aiding in the navigation of the intricacies of power and knowledge within an evermore interconnected globe (ibid.). On the one hand, affect serves as the overarching term to describe feelings like emotions and moods, representing the internal experiential aspect of feeling. In everyday language, affect, emotion, and mood are often used interchangeably. Affect encompasses emotions and moods, where emotions are brief and intense responses to specific external stimuli, either instinctive or following cognitive assessment. On the other hand, moods are enduring dispositions that are not directly linked to a particular stimulus. Affective states vary in duration, intensity, definition, pleasure, and arousal levels, playing a crucial role in influencing cognitive functions, behavior, and social interactions (Batson et al. 1992). On the other hand, emotions are considered foundational when associated with recognizable facial expressions, like widened eyes and an open mouth indicating surprise. Basic emotions are thought to trigger specific physiological reactions, such as the feeling of nausea in response to disgust. Moreover, these basic emotions are believed to manifest in nonhuman animals, as seen in the fight-flight-freeze response observed in rats. All human languages include words or brief expressions that represent emotional states. While there's debate about the exact number of emotions, commonly accepted lists typically include surprise, fear, anger, contempt, disgust, sadness, and joy. From a specialized point of view, an emotional response becomes a moral foundation if it prompts behaviors and social cues aligning with established norms. For example, contempt is thought to establish a hierarchical social order of dominance and subjection, disgust outlines a concept of purity and contamination, and anger fosters a horizontal ethos of care and non-injury (Alfano 2018).

Anthropologists have long acknowledged the profound impact of emotions on both individual physiology and the broader cultural context. When studying the experience of emotions in the body, researchers commonly resort to indirect measures such as gestures and facial expres-

sions to deduce internal emotional states. In the domain of emotion research, Matthews (2005, p. 5) posits that emotions are an integral component of lived reality, arising from and oriented towards the social sphere. This perspective acknowledges that emotions are not isolated phenomena but are deeply intertwined with social interactions and relationships. Interestingly, an investigation of classical Maya iconography differentiates between emotion and affect. In this context, affect refers to the subjective state attributed to individuals based on their observable behavior, which holds significant social meaning (Fisher & Chon 1989). Affective reactions are not entirely involuntary and ungovernable, but hinge on an individual's inclination, scrutiny, and ability to manage their emotions. These responses are context-dependent, influenced by the situation, personal background, and emotional intelligence (Smith & Campbell 2015, p. 445). Furthermore, every emotional experience encompasses multiple aspects, such as sensations of joy or dissatisfaction, feelings of comfort or unease, and states of arousal or drowsiness (Adolphs et al. 2019). Analysis of Maya culture revealed that certain emotions, such as fear and sadness, were negatively valued within their society. In contrast, a significant focus was placed on emotional moderation amongst elite figures. The focus of this research lies in the shared and socially constructed evaluation of emotional states rather than solely on the objective truth of individual emotional experiences. These divergent points of view underscore the challenges of understanding emotions within cultural settings. While Matthews (2005, p. 5) suggests that emotions are an inherent element of social existence, the Maya case study casts light on the societal values attributed to various emotional expressions and the cultural ideals regarding emotional restraint. Both perspectives provide valuable insights into the complex interconnection between emotions and culture, illustrating the multifaceted nature of emotional experiences.

It is worth noting that these findings align with broader anthropological understandings that emotions are not solely biologically determined, but are shaped by social and cultural factors. Cultural codes, principles, and expectations govern how emotions are perceived, articulated, and valued within a society. Emotions can be envisaged as social and cultural constructs that mirror and play a role in the dynamics of authority, identity, and social interactions (Fisher & Chon,

1989). The methodologies through which emotions are lived, construed, and valued across diverse societies are analyzed by anthropologists when exploring the relationship between emotions, culture, and societal dynamics. These inquiries prompt a reassessment of the perception of emotions as purely private occurrences, urging acknowledgment of their embeddedness in sociocultural frameworks. Such revelations contribute to a more comprehensive understanding of human emotions and their influence in shaping our understanding of visualized data.

9.1 Affective arousal as a form of pathos

Research on affect (emotions) has traditionally concentrated on two dimensions: valence (good or bad) and arousal but with differing intensities. Considerable attention has been paid to valence, while the examination of arousal in emotional experiences has been somewhat neglected in recent times. It has been posited that the interplay between emotional arousal and cognitive style plays a role in task performance. Concordance between cognitive style and emotional arousal enhances performance, whereas discordance hinders it. Arousal impinges on our judgments, information processing, and memory, signaling urgency, significance, and personal salience. Furthermore, studies have shown that words related to arousing topics are more likely to be remembered, as well as words that are arousing even if they are not directly related to the topic (Storbeck & Clore 2008, pp. 1827/1837). Accordingly, studying affect and affective arousal, in conjunction with emotions, proves advantageous in the realm of data visualizations as well. The influence of emotions and affective states in defining the efficacy and impact of visual data representations is increasingly acknowledged by researchers. Recent research in data visualization has shown that small, perceptually specific color palettes used in categorical maps can convey significant emotional qualities. Nonetheless, the interaction of affective aspects of color with the informational context within visualizations remains underexplored (Anderson & Robinson 2021). Still, research by Kennedy et al. (2016) revealed that visualizations can provoke intense emotional responses, which in turn affect viewer engagement. These initial emotional reactions are pivotal in determining the extent of an individual's interaction with the visualization and immersion in the underlying data. The social and cultural environment sur-

rounding data visualizations bears significance, as it shapes perception and engagement. By studying media audiences, researchers have identified six factors that impact user engagement with visualizations (ibid.). These factors that affect engagement in data visualizations are 1. subject matter, 2. source/media location, 3. beliefs and opinions, 4. time, 5. emotions, 6. confidence and skills. They further argue that each visualization-user interaction is unique as these factors come together in different ways. This highlights the challenge for visualization producers to create effective visualizations that consider users' needs, adapt to different contexts, and reflect the diverse influences at play. The results suggest that affectively congruent colors enhance the perception of emotional qualities, especially in maps with positive themes. Design recommendations are provided to balance color congruence with other factors in thematic map design (Anderson & Robinson 2021; Kennedy et al. 2016). Recent research has examined the influence of aesthetic factors on users' emotional responses to data visualizations. Cawthon & Moere's research demonstrated that by measuring task abandonment and incorrect responses, in conjunction with assessing aesthetic preferences, one could better evaluate the user experience. Their findings suggest a correlation between aesthetics and these metrics, suggesting that visually appealing visualizations capture more attention and users are more patient while engaging with them. This underscores the concept that emotions influence problem-solving; affective and cognitive capacities are intertwined. A positive emotional engagement with an object can enhance creative problem-solving. Moreover, affect and general emotions are essential in day-to-day decision-making. This is supported by neuroscientist Antonio Damasio's study on individuals with impaired emotional systems. Contrary to the belief that decision-making is purely rational, these individuals, despite otherwise being healthy, struggled to make choices without emotional input. Contemporary research emphasizes the significance of the affective system in making rapid judgments of good and bad, thereby streamlining the decision-making process (Cawthon & Moere 2007; Norman 2004, p. 12; Funke 2010, pp. 136/138). Although there is a wealth of literature on emotion, affect, and their impact on motivation, problem-solving, and the sense-making process, an in-depth exploration is beyond the scope of this thesis. Instead, this discussion necessitates addressing the critical considerations regarding

the use of emotions in data visualizations. This leads to the question of whether it is morally justifiable to intentionally provoke specific emotions in users and the extent to which this might be perceived as manipulative. The intentional invocation of emotions to sway user behavior in data visualizations demands a critical examination of the ethical implications involved. While there is increasing recognition of pathos as essential for effective communication across numerous fields, its implementation must be cautiously considered to avoid potentially negative outcomes and manipulative tactics.

9.2 Pathos: danger or potential?

During the abolitionist movement, there was a noticeable shift in rhetoric towards using emotions and sentimentality as a means of appealing to people's feelings. This shift can be seen in the increase in pathos-filled slave narratives, sermons, and sentimental novels that aimed to elicit a tearful response from the audience. Termed "moral suasion," this approach intended to lead white readers from both the North and South to a recognition of the shared humanity and emotive capacity of slaves, thereby fostering a sense of unease with the institution of slavery. *Hop-Frog* by Edgar Allan Poe is often cited as a notable example in this context. Critics argue that this heavy reliance on emotional appeals was not merely an attempt at promoting empathy or brotherhood, but rather a strategic propaganda offensive aimed at targeting and influencing white consciences. By focusing primarily on the suffering of individual slaves, without adequately examining the consequences and complexities of abolition, there was a potential oversight of the possible dangers and unintended outcomes of such a movement. This criticism challenges the one-sided emphasis on pathos and calls for a more comprehensive examination of the implications and potential consequences of abolition (Jones 2001, pp. 243/254). An alternate perspective acknowledges the pervasiveness of emotions and their intrinsic role in human exchanges. Instead of minimizing or sidestepping emotions, their acknowledgment is believed to foster the development of significant interpersonal connections. When team members perceive that their colleagues not only understand but also resonate with their emotions, authentic relationships begin to form. These relationships, in turn, create a solid foundation for open

discussions about mistakes, questions, and feedback. By acknowledging and embracing emotions, a supportive and empathetic environment can be cultivated, enhancing collaboration and communication within a team (Venus et al. 2019, pp. 56-57).

9.2.1 Against emotion: dangers of emotional appeals

The use of pathos in data visualization is, as before mentioned, not without its controversies. While emotional appeals can be effective in engaging and persuading audiences (Aristotle 2018, p. 61), they can also be manipulative, leading to biased or inaccurate interpretations of data (Bloom 2014). This has given rise to a growing concern about the potential misuse of emotional appeals for political or commercial gain, which in turn can lead to a fear of manipulation via emotions in data visualization. Prominent among the critics of empathy in general is Paul Bloom. He points to what is known in psychology as empathetic distress – a particularly strong, self-centered response to the suffering of others, which triggers an automatic desire for withdrawal from the affected individuals. Bloom, therefore, advocates for a differentiation between empathy and compassion, postulating that the latter maintains a certain distance (Bloom 2014). Additional criticisms of empathy emerge from studies on its potential to manipulate moral responses. Research, as exemplified by the concept of "vicarious distress" identified by Grynberg et al. (2012), indicates a significant influence on social behavior (Batson et al. 1987; Grynberg et al. 2012). In essence, when another person's suffering elicits identical suffering in someone else, this can lead to defensive or even accusatory behavior. Conversely, a less empathic response can support a more rational decision-making process and clarify whether the other person's suffering is genuinely a cause for moral concern (ibid.). Another viewpoint suggests that empathy can lead to both sympathy and personal distress. Sympathy is characterized by a wish for the other person to feel better, while personal distress refers to experiencing distress ourselves in response to someone else's emotional state. Empathy, often triggered by adopting another's perspective and combined with cognitive processing, can result in sympathy and/or personal distress. Earlier studies on empathy and prosocial behavior perhaps underestimated their relationship due to a failure to distinguish between types of emotional responses

and prosocial actions. Recent research highlighted the importance of such distinctions in understanding the connections between empathy and prosocial behavior (Eisenberg & Fabes 1990, pp. 132-133). Moreover, empathy is problematic insofar as it encompasses a bias—specifically the "similarity bias" (Prinz 2011, pp. 223/229). Neural research by Xu et al. (2009) indicates that people experience greater empathy for those similar to themselves. In other words, empathetic emotions are shaped by likeness; thus, the subject evoking an emotional response must resemble ourselves. Accordingly, Thudt et al. (2016) introduced visual mementos as a new application area in visualization, aiming to create meaning through personal data by evoking familiarity. Neuroscientific studies confirm that empathetic reactions are usually more intense toward those perceived as part of one's group, indicating that people's subjective empathetic feelings are influenced by biases, such as the ethnicity of those whom we empathize with (Talt 2019). Within the discourse on information design and visualization, Edward Tufte emerges as a pivotal figure, acknowledged by Cairo (2013) as "arguably the most influential theorist in information design and visualization" (p. 61). Tufte's contribution includes the introduction of the term "chartjunk," a label he ascribes to content-free misdirection and ornamental embellishments in visualizations. Tufte's aversion to "chartjunk" reflects his suspicion that proponents of decorative elements may perceive raw facts and figures as inherently uninteresting, necessitating adornments to enhance their appeal (ibid.). He contends that if the underlying numerical data lacks interest, the problem lies in the selection of the data itself: "If the numbers are boring, then you've got the wrong numbers. [...] Who would trust a chart that looks like a videogame?" (Tufte 1990, p. 34, as cited in Cairo 2013, p. 62). The issue of trust, as raised by Tufte, holds considerable significance in the realm of data visualization, although a comprehensive exploration of this theme exceeds the confines of this thesis.

9.2.2 Visual embellishments vs. "chartjunk"

It must be remarked that the (academic) visualization community aims to distance itself from the pejoratively connoted term "chartjunk" in science. This countertrend stems from the objection to labeling icons, which are crucial for comprehending visualized data, as "chartjunk".

This is not only inaccurate, according to Akbaba et al. (2021) but also counterproductive for the work in the area of visual concepts (Akbaba et al. 2021). According to them, "chartjunk" has inappropriately evolved into a technical term. In their "Manifesto for Putting 'Chartjunk' in the Trash 2021," they examine the term's terminological history, starting with Edward Tufte. It becomes apparent that the term was originally designed as a provocation to devalue design-centric approaches to visualizations. In doing so, the minimalist philosophy, as advocated by Tufte himself, was promoted as the sole path to veracity (Akbaba et al. 2021). Critique of Tufte's philosophy is not singular to Akbaba et al. (2021). Others have described his style as " serious, cold, and stripped bare of aesthetic attributes," (Cairo 2013, p. 68), prompting the emergence of counterpositions (ibid.). For instance, the aforementioned "Manifesto for Putting 'Chartjunk' in the Trash 2021" but also Donald A. Norman's "Emotional Design" (2004) are reactions to Tufte's minimalism. Norman posits a direct correlation between aesthetics and functionality, arguing that this principle should extend to data visualizations as well. However, Stephen Few warns that overemphasis on aesthetic appeal can lead to its own set of issues. Excessive beautification may undermine the integrity of the data represented, sometimes even compromising it. Yet, even if data integrity is preserved, aesthetics-focused visualizations risk attracting more attention to their design than to the data and insights they purport to convey. Few contends that embellishments in data visualizations should enhance, not detract from, comprehension (Few 2012). In a discourse on the blog *Visual Business Intelligence*, Stephen Few states that effective visualizations necessitate a degree of engagement, though. He defines engagement as an immersive process of exploring and understanding information, uninterrupted by the mechanics of the software. Conversely, he critiques engagement that detracts from productive data interaction. He clearly emphasizes that visualizations first and foremost have the task of communicating information, which subsequently results in understanding (Few 2007). Pat Hanrahan joins the conversation, agreeing with Few that visualizations must inform. Yet, he interjects that "things that are more memorable might be more informative," aligning with Norman's views (Hanrahan 2007). He brings focus to the fact that visualizations can and must be evaluated based on various dimensions, even those that seem very subjective can have measurable effects.

Specifically, he speaks of aesthetics, style, playfulness, and vividness. Especially the aspect of aesthetics is exciting since scientific theories suggest that attractive things are also seen as more usable than non-attractive ones, suggesting the conclusion: "What is effective is often affective" (ibid.). Alberto Cairo concurs with Few on the primacy of knowledge acquisition in visualization. However, he acknowledges the pivotal role of aesthetics, which need not be equated to "chartjunk" (Cairo 2016, pp. 57/59). He also references the visualization wheel, a meta-visualization tool that aids in planning visualizations by balancing features such as "density" (more complex data) against "lightness" (more intelligible data) and "abstraction" (more complex) against "figuration" (more intelligible) (Cairo 2013, p. 51). This tool aptly illustrates how visualizations can evoke empathetic emotions without compromising data integrity. Paul Bloom challenges the integration of empathy into the decision-making process, asserting that impartiality generally results in more equitable and ethical outcomes. He suggests that a hundred nameless deaths are, in reality, more tragic than one named victim and that empathy can bias judgment, making distant lives weigh less than those nearby. Policies and laws can only get better if it is truly understood "that a hundred deaths are worse than one, even if we know the name of the one" (Bloom 2014, p. 15). Bloom posits that compassion – recognizing and acting upon the suffering of others – leads to more actionable outcomes than empathy, which can leave one immobile in their negative emotions (Winerman 2017).

At this point it should be noted that pathos may be a part of empathy, but nothing more: empathy comes from the Greek "empatheia" (passion), which is composed of "en" (in) and "pathos" (feeling). Thus, pathos cannot be equivalent to empathy. Compassion, on the other hand, comes from Latin and is derived from the words "com" (with/together) and "pati" (to suffer). In contrast to empathy, "compassion [...] means feeling for and not feeling with the other" (Singer & Klimecki 2014). Hence, whether discussing empathy or compassion, emotion is an integral element. The appropriateness of employing a sentiment-based approach for universal comprehension in data visualization is a subject of debate. Otto Neurath cautioned against the potential misuse of education solely for professional purposes, highlighting his concern about education competing with entertainment (Neurath 2010 p. 113). Advocating for widespread

education, he held the conviction that intellectual thoughts, presented with ease and clarity, could be comprehensible to everyone, transcending socio-cultural or economic barriers (Cairo 2013, p. 71). Comprehensibility and clarity are the key aspects, one has to mention also Hans Rosling who argued that the individual stories behind the statistics are important, at least as important as the statistics behind the stories (Rosling 2019, p. 128). Especially when working with empathetic emotions in data visualizations, there is a tightrope to walk: On the one hand, the intention is to deliberately evoke empathetic emotions to be able to reach recipients on an emotional level; on the other hand, care must be taken to avoid "chartjunk" and to prevent a distorted presentation of the data. Why then is such a daring approach nevertheless worthwhile? As Hans Rosling put it: "The world cannot be understood without numbers. And it cannot be understood with numbers alone" (ibid., p. 128).

9.3 Rhetoric of clarity

The issue of manipulation invariably revolves around the notion of clarity. Clarity, as emphasized in this thesis, holds significance within the domain of data visualizations. The objective is to link pathos to the concept of clarity and, to some extent, a rhetoric of clarity in connection with the question of manipulation. The exploration aims to delineate the interplay of these concepts with pathos and emotions. Researchers in the field of statistics examined the perceptual impact of data displays to ascertain best practices for achieving clarity. This methodology is deeply entrenched in the "perceptual cognitive-based school of thought," (Kostelnick 2008, p. 117) emphasizing rationality and empirical research in informing data design. The primary goal is to enhance the conveyance of data from designers to users, in alignment with the "transmission" model of communication that Shannon and Weaver introduced in the 1940s (ibid.). Despite these efforts, charts retain the potential to mislead or even deceive. Alberto Cairo emphasizes that the foremost comprehension regarding charts is that they can mislead. Yet, what transpires when we do pay attention? Similar to text or literature, charts or data visualizations employ a certain grammar, a lexicon of symbols, and a myriad of conventions. Recognizing misuse necessitates a thorough understanding and study of these elements (Cairo 2019, p. 21).

This understanding is a subarea of visual data literacy (VDL). VDL is the ability to interpret and effectively utilize data to inform decisions. It includes a spectrum of competencies and knowledge that enable educators to transform data into meaningful information and, ultimately, actionable insight. These competencies involve identifying, collecting, organizing, analyzing, summarizing, and prioritizing data (Wolff et al. 2016, p. 10). While there exist varying definitions and complexities inherent in VDL, the definition provided herein suffices as a foundational understanding for this thesis, illustrating that manipulation is not a fixed or universally applicable term, instead relying heavily upon the proficiency of individuals in reading and comprehending visualizations. When the cognitive-perceptual approach, as advocated by Tufte, is adopted, the recognition arises that clarity is considered a universal principle, presumed to be accessible to all without accounting for individual differences. Within this paradigm, clarity is rendered as an objective benchmark assumed to be universally comprehensible. It endeavors to foster efficient and predictable responses from the reader by optimizing visual comprehension and fostering trust in the data. This standpoint takes cues from the rhetoric of clarity promoted by the Royal Society of London in the 17^{th} century, which advocated for the untainted presentation of facts and truth. Ethically, it posits that designers have a moral imperative to provide full transparency to readers. Historical works, such as Brinton's *Graphic Methods for Presenting Facts* as well as Huff & Geis's *How to Lie with Statistics*, highlight the need for readers to be aware of deceptive data design and equip themselves with interpretive tools to uncover manipulation. As responsible consumers of data, readers must exercise caution and vigilance to protect themselves from manipulative practices (Kostelnick 2008, p. 117).

After this short exploration of clarity and visual data literacy, the topic of (potential) emotional manipulation, focusing specifically on the example of colors in weather maps, will be analyzed next. This subject has been a topic of discourse within the broader community, experts as well as general audiences.

9.3.1 Example: manipulation of weather maps in the news

There is an ongoing discourse about media manipulation, particularly during the summer months, that has elicited considerable attention in Germany. Accusations directed at public broadcasters involve the purported exaggeration of heatwave severity, achieved through alarmingly red-colored weather maps. This alteration in the color schema has initiated vigorous debates over possible intentional manipulation, supposedly to escalate a sense of urgency and exaggerate the perceived effects of climbing temperatures (see Nowotny 2021; Echtermann 2022; Reisin & Siggelkow 2022; Rathmanner et al. 2022). The Austria Presse Agentur (APA) argues that similar accusations were debunked in 2019, and the use of red colors in temperature maps has been consistent for decades. The higher resolution of today's maps and changes in prediction models are said to explain the perception of more intense colors, emphasizing that the color palette aims to represent temperature differences and is not linked to climate change propaganda (Rathmanner et al. 2022). Also, the German Weather Service states that the color red is for storm warnings and violet is for extreme storm warnings. This includes heat warnings, as heat is one of the most dangerous weather conditions. Furthermore, they argue that studies indicate that heatwaves lead to significant increases in mortality. The color choice aims to warn people of the danger, and given climate change, an increase in heat events is probable. The assertion that high temperatures are intentionally depicted more intensely to induce panic is refuted, as the color scheme has undergone only minor changes over time and both the German Weather Service and ARD have essentially maintained the same color scheme, according to the German Weather Service (Trippler 2023). The selection of chromatic scales in temperature mappings is based on tried-and-true design tenets, which strive to convey temperature differentials effectively. The selection of a vibrant red, a color often associated with hazard or caution, is intended to convey the intensity of heat extremes, thereby assisting in the communication of the searing temperatures' gravity (Reisin & Siggelkow 2022; Rathmanner et al. 2022). Despite differing practices, a shift is occurring toward a standardized application of design principles and color scales in meteorological maps, to enhance clarity and facilitate the accurate interpretation of climatic data. Through the implementation of uniform design elements, public broadcasters

hope to offer a consistent and readily comprehensible viewing experience. The intention is not to engender manipulation or to overstate the depiction of heatwaves, but rather to render the data visually accessible (Reisin & Siggelkow 2022). By steering the conversation toward a more informed and data-driven understanding of climate science, productive dialogues may be encouraged, leading to effective measures to combat this exigent global challenge (Nowotny 2021; Echtermann 2022; Reisin & Siggelkow 2022). The use of colors in weather maps, particularly in the depiction of heat and storm warnings, is, in a way, connected to the rhetorical concept of pathos. In this context, the use of intense colors such as red and violet in weather warnings could be considered a means to generate emotional impact. By visually highlighting extreme weather conditions, especially heat, an attempt is made to elicit an immediate response from the audience. The color choice potentially amplifies the perception of the seriousness and urgency of these weather phenomena. It is important to note that the use of pathos could after all be intended to raise awareness of potential dangers and promote an appropriate response. The connection of pathos with meteorological color codes ultimately serves a communicative purpose, although the populations' reaction to such a purpose can vary greatly, as this example has shown. Moving forward alongside the dialogues on media manipulation, the impact of data visualizations as a political factor should be discussed in further detail.

9.4 Data visualizations as a political influence

The concept of neutrality, frequently referred to as a cornerstone of scientific and journalistic objectivity, has been increasingly questioned in recent years. The belief that absolute neutrality can be achieved attainable is fundamentally flawed, as all knowledge is inevitably shaped by the perspectives and experiences of individuals who bring distinct cultural, historical, and geographical backgrounds to bear (Kostelnick 2008; Correll 2019). Instead of striving for an unattainable neutrality, feminist philosophers advocate for the pursuit of feminist objectivity, which aims to create a more inclusive form of knowledge (D'Ignazio & Klein 2020). Feminist objectivity acknowledges the fact that knowledge is, by nature, situated, and is produced by individuals with unique positions. Standpoint theory, a pivotal component of feminist episte-

mology, illuminates the viewpoints of marginalized groups, which are habitually sidelined and omitted from conventional knowledge production processes. This theory accentuates how an individual's social posture and lived experiences affect their comprehension and interpretation of the world. Moreover, positionality recognizes that individuals enter the processes of knowledge production from various positions, molded by their cultural and contextual environments. This, in turn, also influences people's perceptions of clarity. What may present as clear and understandable to one may not be the same for another (Kostelnick 2008). Aligned with principles of transparency and acknowledgment of the inherent limitations of one's knowledge, the disclosure of one's subject position(s) emerges as a significant strategy within feminist discourse. Rather than viewing these positions as drawbacks or sources of bias, they are recognized as valuable perspectives that enrich ongoing work. Embracing and acknowledging the contextualized nature of knowledge enables data science to explore novel research inquiries and develop innovative methodologies. This inclusive approach fosters a more diverse knowledge landscape, which challenges prevailing narratives influenced by the concept of universal objectivity (D'Ignazio & Klein 2020). Feminist objectivity recognizes the situatedness of knowledge, fostering a more just and equitable society. This paradigmatic shift moves away from the illusion of neutral objectivity towards a more inclusive comprehension of the world. This approach promotes a more inclusive and diverse knowledge production, challenging the dominant narratives perpetuated by the notion of universal objectivity (ibid.). Dörk et al. (2013) further endorse this shift, believing that the emergence of visualizations to stimulate consciousness and "outline visions for change" (p. 2189) is a positive development. It signifies that as data visualizations gain prominence in society, their cultural integration deepens (ibid.). To consider cultural embedding is to grasp the rationale behind individual behavior and its impact on the networked ecosystem wherein people inhabit and operate. Choices are made against the canvas of one's sociocultural milieu (Wu & Pullman 2015). This means, that data visualizations carry political significance insofar as they also affect how matters are represented, delegated, interpreted, and potentially marginalized. In many instances, public visualizations lay the groundwork for collective decision-making. Therefore, framing data visualization as non-political and purely

analytical is no longer appropriate, as, for example, non-representative data sets also bias the visualization built upon them (Baumer et al. 2022). Visualizations, by their very nature, capture but a fraction of reality. Highlighting and omitting are intrinsic qualities of data visualizations. Both of these methods can enhance comprehension of the data depicted, but can also obscure underlying patterns. It falls to the designer of the data visualization to determine which information is revealed and which is concealed (Dörk et al. 2013). This in turn leads back to Correll, who states that the collection of data before the digital age served, among other things, to determine the tax base for the population, for example, and thus automatically can no longer be non-political. He even takes it a step further and notes that "the proper data set can help start wars" (Correll 2019, p. 2). Given the increasing importance of visualizations, the significance of values and intentions in visualization practices needs to be a matter of discourse (Dörk et al. 2013). This growing significance of visualized data underscores the necessity to synthesize extant theories to derive techniques and methods to potentially increase engagement with data visualizations by the ethical use of emotions.

10 Pathos in data visualization

Once, there is an acceptance that data are never neutral (Correll 2019), other rhetorical techniques, such as pathos, have a better chance of being accepted. Also, with the rise of big data and data analytics, the use of pathos techniques in data visualization has become increasingly important, as it allows for the translation of complex information into a form that is easily understandable and relatable to a wider audience (Campbell & Offenhuber 2019; Kostelnick 2016). Rhetoric, which has experienced various interpretations throughout history, was once integral to ancient societies where full male citizens engaged in public discourse to influence political and legal decisions. Aristotle was among the first to develop a systematic representation of the art of oratory. He defined it as the ability to consider what might be persuasive in any matter (Raaflaub 2013). Moreover, the need to legitimize power has been a recurring theme through the ages, particularly for monarchs lacking inherent personal charisma. These

rulers often relied on visual representation to assert their authority, which is visual rhetoric in some way (Meister 2021). Yet rhetoric has not necessarily been viewed as a positive thing. In the following, the historical background and evolution of pathos in data visualization will be investigated to draw comparisons between its utilization in this field and its application in the fine arts and humanities and to highlight the political implications of its use.

10.1 Historical outline

During the Age of Enlightenment, rhetoric was criticized for diverting attention from rational thinking. This criticism grew stronger in the late 18^{th} century with the rise of the aesthetics of genius. Now, speeches were valued for their emotional authenticity rather than skillful techniques. Rhetoric faced moral scrutiny as a manipulative "art of dissimulation," resulting in its decline as a teaching subject in the 19^{th} century. Even Goethe, who had rhetorical training, disapproved of it. Kant viewed oratory as questionable since it exploited opponents' weaknesses, making it unworthy of respect (Ueding 1997). Interestingly, the historical background of the aesthetic concept of pathos, which can also be considered separately from rhetoric, is somewhat different. At the end of the 18^{th} century, Johann Georg Sulzer probably marked the peak of the pathos-theory within the fine arts when, in his book "Allgemeine Theorie der schönen Künste" (1771, engl. "A General Theory of the Beautiful Arts"), he described pathos as the nature of great souls. Pathos, in its historical meaning, describes a certain kind of suffering that shapes a person and which provokes strong emotional arousal. Attempts to create pathos have often consisted of depicting severe pain and misery to persuade the audience or to enhance their catharsis. With time pathos became symbolic for a movement of the soul, a so-called soul affect (Gessmann 2002, pp. 724-725; Munteanu 2011). However, there are two situations where people don't expect to suffer: either they are extremely prosperous and have become arrogant, or they have endured so much suffering that they are indifferent to future hardships, like those facing execution. However, there must be some hope for deliverance from their current anxiety, as fear prompts people to consider their options, and no one deliberates about a hopeless situation (Aristotle 2018, p. 73). Thus, pathos can be recognized as a form of Aristotle's appreciation

towards emotional appeals that opens up the opportunity to reach a certain target audience and convince them "to think in particular ways" (Slovic & Slovic 2015b, p. 15). These Aristotelian thoughts can also be found in other disciplines, such as discourse analysis and literary or film criticism. However, the search for a balance between ethos (credibility and authority), logos (logical conclusion) and pathos (feeling, emotional appeal) is an essential challenge, the importance of which has been increasing over time (ibid.), though, in the 19^{th} century, the concept of pathos then transformed: away from an ideal towards an attempt to categorize pathos. This aim to classify pathos as a category is reflected in the art-historical term of the "pathos formula" coined by Aby Warburg (1866-1929) (Busch & Därmann 2007, pp. 7-24; Zumbusch 2010, pp. 7-21). The importance of pathos continued to decrease until, in the 20^{th} century, the term was more and more associated with exaggeration, kitsch, and triviality (Zumbusch 2010, p. 11). This minimal historical outline of the concept of pathos is therefore relevant for this thesis as there has been a similar development regarding the creation of empathetic emotions in the field of data visualization. Charles Kostelnick provides a historical perspective relating to the use of pathos in data visualizations. He calls the 19^{th} century the "golden age of statistical graphics", a term he borrows from H. Gray Funkhouser (1937). Victorian and romantic values are dominant in this so-called "golden age", and these values are reflected in the design of contemporary data visualizations (Kostelnick 2016). Karl Marx introduced a new meaning to rhetoric, especially in communism. A socialist rhetoric with special terminology evolved, which interpreted political conditions in the sense of Marxism and supported the argumentation of its representatives. However, this led to the oratory being viewed negatively in civil circles (Albrecht 2011). In the second half of the 19^{th} century, in particular, an increasing variety of new graphic forms emerged. Kostelnick cites the famous flowchart describing Napoleon's Russian campaign (1878) as an example, also known as Minard's map. It was also during this period that quantitative information was first presented in new forms of media, such as U.S. statistical atlases or French national statistics albums. This not only made data visualizations accessible to a wider public but also created empathetic emotions by using a combination of physical and psychological stimuli, lavish color, pictorial elements, and innovative genres. Similar to the his-

torical development of pathos in the field of fine arts, the acceptance of appealing to empathetic emotions started to decrease steeply in data visualizations of the 20^{th} century. Kostelnick sees an explanation of this avoidance of pathos in the rise of new modernist minimalism – empathetic emotions simply had no place in serious data visualizations. In recent years, however, a more open attitude towards the use of pathos, in culture, politics, and data visualizations, can be noted (Kostelnick 2016; Hayer 2021). This leads to the question: What are the advantages of emotional appeals in data visualizations?

Yun Wang et al. (2019) point out the role that human emotions play, especially when dealing with data: they influence understanding, transmission, and exploration of the data (Wang et al. 2019). Seen from a cognitive science perspective, it is clear that emotions are directly linked to motivation or learning (Crossmann 2007; Mega et al. 2014, Okabe-Miyamoto et al. 2022; Tyng et al. 2017). Positive emotions influence motivation and self-regulation in ways that improve academic learning, for example, negative emotions can do the exact opposite (Mega et al. 2014; Okabe-Miyamoto et al. 2022). This begs the question, why then is the element of pathos, as a form of suffering or intense feeling, a good choice as a rhetorical device? In terms of emotional valence, people tend to pay more attention to emotions perceived as negative than positive. This is because the negative represents a potential threat and one needs more cognitive resources to cope with such threats. This assumption is supported by the negativity bias, which states that negative emotions attract more attention than positive ones, even in the area of social media, and thus generate more engagement (Zhao et al. 2022). However, this contrasts with the practical day-to-day life of the majority of those practicing visualization research: there, emotions are rarely even explicitly considered (Wang et al. 2019). The general approach to the representation of scientific data is to let the viewer explore the data themselves and use this information to draw their conclusions. Of course, these conclusions can provoke emotions, but "it is not the job of the visualization to arouse those feelings directly" (Montañez 2016). The assumption that visualizations themselves are completely devoid of emotions seems out of date (ibid.). Yet, it does make a difference whether emotions are simply "transported along" in visualizations or whether they are specifically intended to be evoked. This also encourages

the theory that empathy is often used by journalists as a means to make problems of the world more tangible. In the field of data visualization, this would be a form of contextualization, which needs to happen to tell a story with the visualized data and the numbers behind the visualization. The aim is to tell a story, that touches people while also providing a close and wide view of a specific problem area within a certain community (Bui 2019). The concept of pathos has the potential to become an important component of contemporary data visualizations because, as Kostelnick points out, "[d]esigners who understand this dimension of data design can deploy technology to make their displays more engaging, humane, and usable" (Kostelnick 2016). In addition, he proposes three specific ways in which the revival of pathos has been able to enhance data visualizations:

1. enlivening sensory stimulation, e.g., through the use of color and animation
2. creating spatial and temporal proximity to the recipients through enabling the interaction with the data visualizations
3. promoting expressive design, as this is intended to appeal to an aesthetic level within the recipients, to encourage them to interact with personal data, which also increases the closeness between user and designer (Kostelnick 2016).

Rhetoric experienced overall a renaissance in the 20^{th} century. A renewed interest in rhetoric in Europe and North America led to talk of a "return of rhetoric". Nietzsche and Heidegger, in particular, have inspired other and following philosophers and theorists to return to the debate on rhetoric (Anschütz et al. 2021, pp. 1-3; Kopperschmidt 2009, pp. 9-12). Today, we are witnessing a change in how scientists and designers view rhetorical methods like pathos or affect more generally, as evidenced by the increasing number of published papers on this subject (e.g.: Campbell 2018; Kostelnick 2016; Lan et al. 2022b; Lee-Robbins & Adar 2022). It appears that pathos may be experiencing a resurgence, as its emergence as a topic of discussion within the scientific community suggests.

10.2 Pathos in data visualization: an example

To fully grasp the potential of pathos in the realm of data visualizations, it is essential to explore a concrete example that vividly demonstrates how pathos can manifest in the visualization of data. This example serves the purpose of not only fostering a deeper understanding but also providing a comprehensive perspective right from the start. Imagine a data visualization representing the Iraq War. Instead of presenting only numerical data, pathos could be used to establish an emotional connection and emphasize the gravity of the situation. For example, such a visualization could illustrate the increasing number of civilian casualties over time. This visualization might employ a striking color palette transitioning from calm blues to vivid, attention-grabbing reds, capturing viewers' attention and evoking a sense of urgency and unease. Moreover, pathos could be effectively employed by incorporating narratives and personal experiences into the data visualization. By featuring individual stories of those affected by the consequences of the Iraq War, such as farmers enduring droughts or coastal residents whose homes are threatened by rising sea levels, the emotional connection with the audience can be strengthened. These stories evoke empathy and compassion, thereby fostering greater engagement and motivation to address the issue and take action. Figure 5 shows that data is not just a collection of numbers; it is a language that conveys opinions and arguments. This is the perspective shared by Kim Rees, co-founder of Periscopic, emphasizing the power of data in shaping narratives (Cotgreave 2016). "Iraq's Bloody Toll," designed by Simon Scarr and published in the South China Morning Post, demonstrates how data visualization can effectively communicate different valid opinions. The chart depicts the monthly death toll in Iraq from 2003 until the beginning of the US troop withdrawal in 2011. The visual metaphor employed in this chart influences how it is interpreted. The title, "Iraq's Bloody Toll," immediately sets the tone and agenda of the author. The downward orientation and the red color of the bars intensify the emotional impact. The viewer perceives a visual representation akin to blood dripping down the screen or page. Rather than being deceptive, The choice of design was deliberate, intended to represent a "visual metaphor of blood" (Scarr n.d.) to draw the viewer into the graphic and thereby creating a powerful effect (Muth 2016; Wanf et al. 2008; Samsel et al. 2018). The

visualization was rightfully recognized with a silver award at the 2012 Malofiej, an annual infographics awards conference (Cotgreave 2016). Set into comparison, it becomes clear that one visualization (the unemotional version, symbolized as 1,000 in Figure 5) addresses the analytical, whereas the other one (the emotional one, symbolized as a heart in Figure 5) appeals to the emotional side of the viewer. This shows that by using the affective color theory it is possible to make data visualizations more engaging (Muth 2016; Samsel et al. 2018).

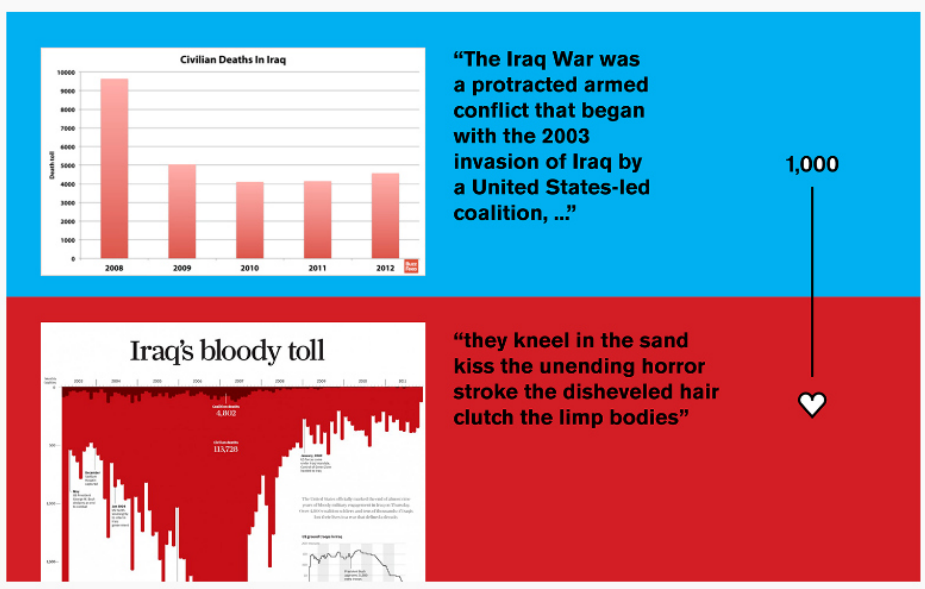

Figure 5: Comparison of two different design approaches: "Iraq's bloody toll" by Simon Scarr (n.d.) and a visualization from Buzzfeed (North 2013). Both visualizations use the same topic but differ in design (Comparison originally from Lisa Muth (2016)).

10.3 Proximity techniques to create pathos

Emotions are part of human existence, including the realm of maps and data visualizations. Paul Watzlawick and other scientists noted that "one cannot not communicate" which suggests that emotional effects are also unavoidable. This maxim stands as the initial axiom out of Watzlawick's five, crafted to underpin the theories of communication. These axioms were designed to provide a framework for understanding the inherent nature of communication, the role of behavior and emotion, and how individuals interact and exchange meaning in various contexts.

According to these principles, behavior has no opposite or absence; it always conveys a message that influences others, who in turn cannot refrain from reacting and thus, at least in the context of co-presence, communicate. People express themselves verbally and/or nonverbally, continuously engaging in behavior throughout the communication process. As a result, they mutually influence each other at every moment. Communication is always a cause and effect; it is circular in nature. This axiom highlights the notion that even in the absence of explicit verbal communication, nonverbal cues and actions continually transmit information and evoke responses (Hahne 1998, pp. 232-233; Lubienetzki & Schüler-Lubienetzki, 2020, p. 12). Hence, it makes sense to connect pathos – an appeal to emotion – with this principle. Nonverbal cues, such as facial expressions, gestures, or vocal tone, serve as powerful means of emotional expression, capable of eliciting various emotional responses in others and enhancing the communicative effectiveness of behavior. For example, when presenting maps and data visualizations, conveying vital information goes beyond the raw data. This thesis contends that there is not a single objective method for visualizing data. Acknowledging the inherent subjectivity and impact of visualizations permits a more nuanced assessment of design decisions and their impact on viewers. In essence, just as nonverbal cues evoke emotions, visual elements in data representation carry subjective aspects that influence viewers' interpretations and responses. Psychological research underscores the challenge of eliciting emotional responses and empathy through data. Mother Teresa's famous quote "If I look at the mass, I will never act. If I look at the one, I will", emphasizes the paradoxical indifference caused by large numbers, which psychologists attribute to our thought processes. There are two systems, the experiential system, responsible for intuitive and emotional reactions, and the analytic system, associated with logical reasoning. While the analytical system would assign equal value to each life, studies show that the experiential response diminishes significantly when considering multiple individuals. In essence, numbers fail to communicate the importance of individual lives. Thus, large numbers can desensitize people, masking the value of individual lives. This viewpoint coheres with a purely rational approach to visualization; however, it omits emotional depth. Without emotions, information lacks meaning and fails to guide judgment and decision-making. Research indicates that proximity techniques,

including highlighting significance, temporal nearness, and spatial relevance, elicit emotional responses within visualizations (Campbell & Offenhuber 2019, pp. 71-72). Proximity techniques, however, are not a new phenomenon. Historical figures have utilized such strategies to sway their audiences effectively. Analyzing passages from the Attic orators reveals that their selection of examples was far from random. Familiarity played a significant role, with recent and domestic events being favored over ancient and foreign ones. Manipulating the audience's temporal and spatial perception, speakers framed examples as "ancient" or "recent" and employed apostrophes to create the illusion of a timeless and unified audience. By generating a sense of shared knowledge and enhancing credibility, these techniques shaped the cognitive and persuasive impact of historical analogies (Maltagliati 2020, pp. 95-97). In conjunction with these proximity techniques, Nietzsche introduced the pathos of distance. Though this idea appears to contradict the pathos of proximity, both aim to generate an emotional response. Hence, the pathos of distance warrants a brief exploration and analysis in the subsequent discussion.

10.3.1 Pathos of distance

Friedrich Nietzsche's stance towards science has often been viewed as ambiguous, if not outright antagonistic. Nietzsche postulated that nature is characterized by chaos, devoid of intrinsic properties or structure, and a proliferation of random chance events. He posited that the semblance of order we perceive is a human construct. Our bodies enable us to perceive nature as a cohesive entity because we interpret, organize, and imbue its chaos with meaning. The intellect receives a raw text through bodily interactions with reality, which is then assimilated, adjusted, and transformed into a controllable and meaningful environment through interpretation, rectification, and falsification. Science, as a practice, was developed to make nature predictable, enabling it to be lived in and managed to some extent (Zwart 2019, p. 458). Nietzsche's concept of the "pathos of distance" describes a psychological and philosophical disposition marked by a detachment from the prevailing social norms and values. This pathos, Nietzsche asserts, is the default posture of the elite in a deeply hierarchical aristocracy. It is seen as the driving force behind the continual enhancement of the human type. The pathos of distance involves looking

afar and down upon others, cultivating a craving for expanding distances within oneself, and seeking higher, rarer, and more comprehensive states of being. It signifies the constant self-overcoming of individuals, leading to the continual development and advancement of human potential. Nietzsche's philosophy emphasizes the importance of exceptional individuals who bring meaning, creativity, and justification to the social order while encouraging the pursuit of elevated spiritual states that make life worth living (Stan 2018, p. 212; Strobel 1998, pp. 18/43). Inherently, the "pathos of distance" embodies the dialectic – the polar contrast of pathos and distance, the Dionysian and the Apollonian – that delineates Nietzsche's creative intent. Traditionally, pathos and ethos symbolize different artistic parts in rhetoric, yet Nietzsche fuses them, generating a strain of divergent artistic impulses. The "pathos of distance" is the driving force behind the ethos of distance. It represents the passionate fulfillment of maintaining distance and encompasses the ethical dimension of not appropriating (Stan 2018, p. 212; Strobel 1998, pp. 18/43). Moreover, the Nietzschean "pathos of distance" is not merely an aspect of his philosophy, but the very essence, wherein a detachment from immediate judgment and valuation is maintained. It entails the contemplation of the world from vantage points unbound by the exigencies of judgment, culminating in a philosophical pathos, a life-affirming yes even amidst the gravest challenges. This kind of affirmation is only made possible outside the realm of judgment (Strobel 1998, p. 18). This approach highlights the importance of metaphors in scientific discourse, even in abstract and technical forms. To enhance the relevance and depth of analysis, it is suggested to replace the "pathos of distance" with a pathos of proximity. Philosophers of science should engage with scientific practice, understanding the actual conduct of research and the technical aspects involved. "[I]n order to be convincing, a Nietzschean philosophy of science would require an attitude of proximity, dialogue, and interaction" (Zwart 2019, p. 458).

10.4 Identification as a factor for pathos

Proximity can be established through the moment of identification, understanding another's choices, and being able to empathize with them. Aristotle's concept of prohairesis (originating from Aristotle's Nicomachean Ethics, meaning 'choice' or 'decision making') emphasizes the

emotional engagement of the speaker as crucial in shaping the audience's responses. Merely relying on logical arguments falls short; effective persuasion requires the use of pathos and the skill of sublimity to engage audiences on an emotional level (Aristotle 2018, p. 146; Vetter 2017, p. 142). This emotional resonance is further highlighted through the lens of theatrical metaphors, which prove to be powerful tools for evoking feelings from audiences. By strategically employing pathos, speakers and performers can stir emotional reactions, fostering empathy, and prompting viewers to contemplate the gravity of the portrayed scenarios. Through metaphorical language, both performers and audiences partake in a collective emotional journey, enhancing identification with the narrative (Berger 2013, p. 6). Plato's perspective on rhetoric adds depth to this discourse by framing it as a process of subjectivization, where rhetoric not only influences but also aids in self-realization. When combined with Aristotle's concept of probabilistic reasoning (this includes making persuasive arguments based on what is probable or likely to be true rather than relying solely on strict deductive logic or certainty), rhetoric becomes a pathway for audience identification and personal growth. However, arguments that are incomprehensible to the listeners may hinder this process, creating a disconnect in understanding and impeding rhetoric's transformative potential (Taureck 2017, p. 27).

In 1946, Nino Frank elucidated subjectivizing procedures in narration in which a narrator relays events from a personal perspective, thus mirroring the protagonist's psyche. The film "Double Indemnity" (1944) utilizes voice-over narration as a narrative device to delve into the psychological intricacies of its protagonist. This cinematic technique played a big part in minimizing the psychological gap between the viewer and the character, thereby enhancing the process of identification (Mosel 2009, p. 93). This moment of identification is not only present in movies but also in art, philosophy, and video games, making it a prevalent issue in cultural workshops of all stripes. In video games, subjectivity grants access to reality by immersing the player and infusing the game world with personal experience. What is often underestimated is the potential of aesthetics to fully engross the viewer or player, similar to the experience with works of art or religious texts. Creating player identification with game characters is a big task, aiming to make players feel deeply connected to the characters emotionally, thereby creating

pathos (Rafinski 2009, pp. 213-214). However, pathos can also be used to invoke subjective experience in data visualizations. Through the strategic use of colors, shapes, and animations, data visualizations can evoke emotional responses and foster deeper viewer engagement. Drawing parallels with the immersive nature of computer games, the goal is to immerse the user in the visualization experience. Incorporating personal narratives and emphasizing emotional aspects can enhance the connection between the viewer and the data being presented. These insights reveal the complex interplay between rhetoric, emotions, and power structures. Rhetoric, when applied appropriately, possesses the ability to influence emotions, foster empathy, and influence decision-making processes. However, rhetoric can either empower individuals through self-discovery or reinforce power imbalances depending on how it is wielded. The understanding and deliberate use of pathos, along with ethical considerations, contribute to effective and responsible communication practices. Therefore, the seven circumstances outlined by George Campbell, a rhetorical framework from the 18^{th} century, is analyzed in the following section to examine how rhetorical devices, particularly pathos, are employed by contemporary visualization designers to gain a better understanding of rhetorical techniques.

11 Pathos-techniques to appeal to emotions via data visualizations

Ancient frameworks, though centuries old, remain pertinent today, demonstrating the enduring relevance of their principles. Subsequently, George Campbell's rhetorical framework will be explored, focusing on its concrete techniques and their potential adaptation for use in data visualization. This analysis aims to compare how these ancient theories hold validity in modern contexts and can be reinterpreted to enhance data visualization practices. Similarly to Aristotle, George Campbell (1719-1796) discusses a "philosophy of rhetoric", also assuming in his era that speech is the primary medium. Campbell acknowledged that emotions – and the circumstances that evoke them – play a crucial role in his rhetoric, positing that when "persuasion is the end, passion also must be engaged. If it is fancy which bestows brilliancy on our ideas, if it

is a memory which gives them stability, passion doth more, it animates them" (Campbell 2008, p. 77). By "passion," Campbell refers to what Aristotle identifies as pathos. Whereas Campbell already recognized in his own time the danger that "passion" represents, he takes the position that rhetoric could not be dismissed as an "art of deception", but rather that this art needed to be better researched and, in most cases, it was legitimate, if not necessary to be used as a form of legitimate persuasion (ibid.). Correll similarly contends that data visualizations, which also aim to persuade, are inherently rhetorical. He highlights that every visualization is a rhetorical device with "the potential to persuade" (Correll 2019, p. 188). If the inseparability of fact and emotion is acknowledged and assuming adequate factual knowledge, the question arises: How does pathos manifest itself in data visualizations? How do data visualization designers employ pathos techniques, consciously or unconsciously?

11.1 George Campbell's seven circumstances to create empathetic emotions

The following examination starts with George Campbell's identification of seven circumstances described as "chiefly instrumental in operating on the Passions" (Campbell 2008, p. 81): probability, plausibility, importance, proximity in time, connection to place, relations to persons concerned, and interest in the consequences (Walzer 1999, p. 82). These circumstances are deemed particularly relevant within the realm of data visualization and warrant further exploration.

One of the most influential contributions to emotionally engaging an audience or, in this case, viewers, was made by George Campbell. These techniques can also be applied to data visualizations. An overview of the seven circumstances and the associated methods for data visualization is provided in Table 2, which will be elaborated upon later. This table was compiled by analyzing the content of the relevant literature identified during the literature research. Then, this literature was analyzed for its relation to the seven circumstances, and methods sharing similar objectives were selected as representatives. The data visualization methods were extracted from theoretical literature and empirical studies. It is important to note that Table 2 does not

aim for exhaustive coverage across all fields but rather seeks to underscore the theoretical points outlined in this thesis. Visualizations corresponding to individual circumstances are explicitly labeled as examples.

Circumstance	Methods for data vis	Theories & studies	Examples
1. Probability	Reliable data, functionality	Kennedy & Hill 2018; Rosling 2019; Tufte 1990, 2006, 2007	Jordan 2006; Scarr n.d.; Reuters 2022, Halloran et al. n.d.
2. Plausibility	(Data) storytelling	Martinez-Maldonado et al. 2020; Seja 2019; Dahlstrom 2014; Matei & Hunter 2021	Knaflic 2015; Halloran et al. n.d.; Fengler et al. 2022
3. Importance at what's at stake	Personalizing the data	Rawlins & Wilson 2014; Kostelnick 2016; Bylinskii et al. 2017	Campbell & Offenhuber 2019; Fung 2016; Reuters 2022; Wallach et al. 2021
4. Proximity of time	Inserting prediction, temporal proximity	Campbell & Offenhuber 2019; Kim et al. 2017; Kim et al. 2019	Ross 2021; Fengler et al. 2022; Webster & Jenniskens n.d.
5. Connection of place	Spatial proximity, role-playing game	Campbell & Offenhuber 2019; Harris 2015; Lan et al. 2022b	Wallach et al. 2021
6. Relations to persons concerned	Humanizing data, anthropographics	Kennedy & Hill 2018; Lan et al. 2022b; Harris 2015; Rosling 2019; Morais et al. 2021	Gosh 2021; Periscopic 2018, Scarr n.d.; Koop & Routley 2021
7. Interest in the consequences	Subject matter, proximity to interests	Campbell & Offenhuber 2019; Kennedy & Hill 2018; Huang et al. 2015	Luccioni et al. 2021; Ratti et al. n.d.; Smith 2015; Webster & Jenniskens n.d.

Table 2: Overview of Campbell's seven Circumstances and corresponding methods and empirical studies relevant to data visualizations, as well as examples for each circumstance

11.1.1 Probability

The first technique to create an empathetic emotion is referred to as "probability," which pertains to the rational inquiry of how credible the visualized data appears to the audience. In the context of data visualizations, Campbell's concept of probability aligns closely with the actual data that serves as the foundation for the visualizations. Yet, the question arises: How might this be leveraged to emotionally engage the audience?

Kennedy & Hill (2018) noted in their research that the data itself plays a role in appealing to emotions in data visualizations, noting that separating the different aspects that trigger and influence such an emotional response is quite difficult. Data that are particularly striking, such as statistics on the number of animal species facing extinction or the potency of a nuclear bomb, can incite emotional reactions in the audience (ibid.). Although these emotional responses may not directly represent empathy or pathos, they establish a foundation for eliciting empathy through additional techniques. George Campbell (2008) emphasizes that although probability is essential, it alone is insufficient: "When the other end alone is attained, the rational without the pathetic, the speaker is as far from his purpose as before" (Campbell 2008, p. 78). The visualization "Iraq's bloody toll" in Figure 5 exemplifies how an emotional response can be evoked by using different design approaches, to make it more relatable to the viewer. Still, when something highly unlikely occurs, it makes other unlikely events seem more likely too. However, this is not always true. Aristotle argues that just like how people misrepresent facts in arguments if they don't consider the context, the same can happen in rhetoric because probability isn't always absolute; it depends on the circumstances (Aristotle 2018, p. 115).

11.1.2 Plausibility

Due to advances in modern technology, an increasing variety and volume of data can be collected. The challenge, however, lies in processing this data to make it comprehensible to a wide audience. Visualizations and the capacity to narrate stories with data are "key to turning it into information that can be utilized for improved decision-making" (Knaflic 2015, p. 2). As described in Table 2, the related design strategy to the second circumstance "plausibility" is

labeled data storytelling. This circumstance underscores the importance of crafting narratives that make sense for an audience, as highlighted in studies such as those by Matei & Hunter (2021) as well as Neifer et al. (2020). Additionally, there has been research in narrative visualization design space, meaning visualizations intended to convey stories. Segel & Heer (2010) discovered genres and elements that harmonize author-driven structure with reader-driven interactivity, showcasing storytelling as the art of captivating and sustaining people's attention over an extended duration. The significance of this concept has been acknowledged in the field of data science, leading to the emergence of the principle of "data storytelling" (Neifer et al. 2020). This term describes the effective communication of a data set's content to a designated audience. Experts state that numbers by themselves are insufficient for conveying meaningful information; they must be contextualized to be understood. Data storytelling offers a method for converting data points into narratives (Heath & Abrahams 2022). A study by Martinez-Maldonado et al. (2020) demonstrates that a layered storytelling approach can lead to more profound reflection among viewers. The objective is to render multimodal data streams intelligible to non-experts through data storytelling (Martinez-Maldonado et al. 2020). Moreover, data storytelling, particularly when the story subverts the audience's expectations, can significantly enhance engagement with the data (Matei & Hunter 2021).

An example of how data storytelling is being used today is "The Fallen of World War II," an infographic video with an accompanying interactive version that presents a compelling narrative regarding the scale of U.S. soldiers' deaths during World War II (Halloran et al. n.d.). By framing the incomprehensible numerical data within a socio-political context, " The Fallen of World War II" tries to render it more plausible to the public. However, it is subject to criticism that, although the interactive visualization employs registered public data sets, its storytelling does not depict an objective reality. Instead, it utilizes cinematic techniques to design and organize each frame (Ocak 2021).

11.1.3 Importance

In this context, "importance" presupposes the theoretical notion that emotional responses are heightened when individuals within the target audience attach significant importance to people, places, events, or similar entities (Campbell 2008, p. 86). Such a circumstance poses a challenge given the inherently subjective nature of personal importance. However, one may address this by articulating the importance of a subject in a manner that is comprehensible and relatable, enabling individuals to contextualize numerical information effectively. For instance, Jake Hofman and Dan Goldstein, researchers at Microsoft, have been leading a project called the Perspectives Engine for nearly a decade. Their objective has been to create tools that render numerical data more intelligible to the layperson. In their studies, they enhanced numerical search results on Bing, Microsoft's search engine, with concise "perspective phrases." Rather than simply stating that Pakistan spans 340,000 square miles, they would offer a comparative statement such as, "That's approximately the size of two Californias." Their findings indicated that even the less conventional comparisons were more impactful than the isolated figures. The inclusion of a solitary perspective phrase decreased error rates by 50% when participants attempted to recall specific details, thereby underscoring the efficacy of framing numerical data in human terms (Heath & Starr 2021, p. 4). Visualization strategies that utilize metaphorical representations of statistical data, as exemplified by the design in Figure 5, can offer a symbolic portrayal that underscores the significance and gravity of the data. This approach is particularly effective when the data relate to subjects such as blood, as seen in representations of casualties in the Iraq War. Utilizing such metaphors serves to convey both quantitative information and evoke emotional responses, shedding light on the human implications of the data. However, careful consideration is necessary when choosing metaphors to ensure they accurately represent the topic without diminishing or sensationalizing it.

11.1.4 Proximity of time

The technique is rooted in the theoretical assumption that people and events in close temporal proximity to the recipients elicit a heightened emotional resonance and response (Campbell

2008, p. 87). However, Campbell is not exclusively talking about events of the past, the concept of temporal proximity is equally applicable to future occurrences (ibid.).

Campbell & Offenhuber (2019) put this method to the test in their research, using a data set related to shelter animals to explore the topic. To instill a sense of urgency and temporal proximity, they included predictions on the number of animals likely to die the subsequent day. The study's results, concerning temporal proximity, indicated an enhanced emotional reaction of the participants. Specifically, emotions such as interest, disgust, fear, and disappointment were experienced more intensely. In particular, "interest" was the emotion most affected by the application of temporal proximity – a conclusion evidenced by the "smallest p-value and the greatest effect size" (Campbell & Offenhuber 2019, p. 83). In addition, data visualizations play a crucial role in augmenting the sensation of temporal proximity, as they can provide real-time data. Real-time or continuously refreshing displays foster a heightened sense of temporal closeness, thereby strengthening the emotional connection to the data. In instances where personal stakes are high, real-time data can provoke reactions such as fear, anxiety, relief, or other intense emotions. Similarly, visualizations of routine activities may evoke feelings of delight, distress, or surprise. The dynamic nature of temporal proximity influences viewers' emotional responses – generating feelings ranging from anticipation and joy to disappointment and sadness (Kostelnick 2016). Jenna Ross, for example, incorporates temporal predictions in her visualization that forecast the fastest-growing and declining jobs from 2020 to 2030. As a rhetorical device, her visualization is particularly effective, according to the studies and theories mentioned, because it encapsulates a forthcoming decade, a time frame that should feel immediately relevant to the audience. Yet, despite intimating that certain jobs may become obsolete due to shifts in employment, the visualization also underscores the creation of new opportunities ahead. This balancing act demonstrates how temporal proximity, coupled with ethically mindful processing of data, can elucidate complex issues without relying solely on negative emotions (Ross 2021).

11.1.5 Connection of place

The connection of place posits that individuals experience more intense emotions towards people or occurrences that are geographically closer to them (Campbell 2008, p. 88). This concept also applies to the realm of data visualization: data that are geographically pertinent to viewers are likely to prompt an empathetic reaction by the theoretical framework. George Campbell claimed that the bond with a specific place exerts a greater affective impact than even a temporal proximity. He regards the geographic connection as influential on human emotions: "With how much indifference [...] do we read in newspapers the accounts of the most deplorable accidents in countries distant and unknown! How much, on the contrary, are we alarmed and agitated on being informed that any such accident hath happened in our neighbourhood" (ibid., p. 88). As early as 1991, studies indicated that emotional engagement correlated with geographic distance on different map projections. This supports the notion, previously intimated by Aristotle, that events occurring farther away elicit less concern. Research conducted by Gilmartin & Lloyd showed an inverse relationship between interest and distance; the degree of interest varied depending on the map projections used. Furthermore, gender and specific geographical regions were found to affect emotional responses, with females showing higher involvement and some regions evoking stronger reactions than expected based on distance alone (Gilmartin & Lloyd 1991). The hypothesis that spatial proximity holds superior efficacy over temporal relations in evoking emotional responses was also tested by Campbell & Offenhuber in 2019. Study participants were granted the autonomy to choose the spatial elements they preferred, resulting in a diverse subset of data. Consequently, this led to exposure to markedly different sets of information, thereby rendering the outcomes incomparable. Campbell & Offenhuber were unable to confirm a statistically significant correlation between spatial proximity and emotional reactions, a finding potentially attributed to the methodology applied in collecting the data within the study (Campbell & Offenhuber 2019). However, another study from 2022, addressing explicitly negative emotions, found contrasting results. This research reframed spatial proximity as a scenario within a "role-playing game." Participants were asked to imagine that one would live in this place and all neighbors would die, this had a great impact on the respondents' emotions (Lan

et al. 2022b). Despite this evocation of distinctly negative feelings, the study underscores the significant link between place and the capacity of pathos to arouse affective responses; the mere conceptualization of being near a disastrous event led to intense emotional reactions from the participants. Correspondingly, the deployment of ClimateData.US – a dynamic visualization tool based on downscaled climate projection data – serves to heighten the sense of proximity and personal involvement in climate discourse. Researchers observed that interaction with ClimateData.US enhanced users' perception of the immediacy of climate change, as well as their conviction about and concern regarding the issue, regardless of their geographical distance from the impacts (Herring et al. 2017). Luccioni et al. (2021) used a similar approach, to show the effects of climate change at a place of the viewer's choice (they could enter an address). They developed an AI-rendered potential visualization of the chosen place fifty years in the future, including possible afflictions by floods, storms, and the like (see Figure 6). This kind of customization permits the induction of the proximity effect, especially if the selected site holds personal significance to the user. Furthermore, more information about climate change and the mechanisms behind it was provided. The goal of this approach was to make the impact of climate change "more concrete and more personal" (Luccioni 2021, p. 12).

Figure 6: An example location by Luccioni et al. (2021), which shows, how an individually chosen place will be affected by climate-change-induced flooding in the future.

Another example, where spatial proximity also plays a role is Treepedia, a visualization tool that allows users to explore the Green Canopy in cities across the globe. The element of

interactivity is again critical, enabling a connection to various locations: Initially, users select from different cities, subsequently accessing city-specific visualizations in a second step. Additionally, Treepedia offers the option to directly compare the "Green View Index" with the "Population Density" across different locations (Ratti et al. n.d.).

11.1.6 Relations to persons concerned

According to George Campbell's theory that emotional responses are more likely to be elicited when the information relates to individuals with whom the target audience has a connection. He contends that "it is the persons, not the place, that are the immediate objects of the passions love or hatred, pity or anger, envy or contempt" (Campbell 2008, p. 89). Such connections can vary widely, encompassing "consanguinity, affinity, friendship, acquaintance, being fellow-citizens, countrymen, of the same surname, language, religion, occupation" and many more (ibid., p. 89). In the realm of data visualization, researchers and designers have experimented with anthropomorphized data graphics, or anthropographics, to engender compassion and empathy in lay audiences, by establishing a connection between the data and the audience. Yet, this field is characterized by a lack of a unified framework and clarity in communication. Striving to address this issue, scholars have begun to suggest conceptual frameworks and design spaces for anthropographics that include different dimensions influencing prosocial feelings and behavior. Notably, during the COVID-19 pandemic, anthropographics served informative, persuasive, and commemorative purposes by simulating the impact of the virus (Morais et al. 2020; Sorapure 2022). However, empirical studies examining the impact of anthropographics on compassion and prosocial behavior have produced inconclusive results. Studies suggest that anthropographics may only have a limited impact on behaviors such as money allocation. However, there are challenges in accurately measuring these effects, including considerations of sample size and inherent variability in such research. (Morais et al. 2021). A visualization by Iman Ghosh (2021) uses proximity to people as a design method. It features the 50 wealthiest women in 2021, displayed on a world map with their photographs. By including images of the women in the visualization, abstract data–comprising facts and names–are transformed into identifiable

individuals with faces. This could inadvertently make the audience react to the aforementioned "similarity bias." Some research explores ways to make data more relatable by highlighting the people behind it. In the study by Lan et al. (2022b), the strategy was to specifically create negative emotions, termed "attachment to reality," intending to connect viewers with the actual scenes and characters behind the data. To implement this strategy, there were several design methods, including "details behind data". For this, a visualization was created where "each circle represents a mother who died during childbirth." By hovering over these circles, viewers could access the detailed profiles of the mothers. The study found that 77% of participants acknowledging this specific design approach also reported experiencing negative emotions (ibid.).

11.1.7 Interest in the consequences

"But of all the connective circumstances, the most powerful is interest", claims George Campbell. He suggests that interest engenders a sense of nearness and evokes empathy in individuals (Campbell 2008, pp. 89-90). Within data visualizations, this element likely corresponds to the "subject matter" (Kennedy & Hill 2018). Research indicates that the subject matter of visualizations can provoke strong emotional responses, such as anger, sadness, relief, or empathy. However, there is a risk when the subject matter sparks hatred or anger, potentially causing recipients to disengage: discouraged by their dislike of the subject matter that they were unable to make a considered assessment of the visualization [...] emotional responses obstructed close engagement" (ibid., p. 838). As a result, when creating data visualizations, designers typically choose their subject matter to pique interest without provoking negative emotional responses that hinder meaningful interaction with the visualization. By selecting a subject matter that aligns with the interests and values of the target audience, data visualizations can attract attention and foster empathetic connections, thus enhancing the viewers' involvement with the content. In the research by Campbell & Offenhuber (2019), the proximity to interests within data visualizations was empirically examined. To this end, statistics from animal shelters were visualized, demonstrating animal survival and mortality rates. Participants were offered a choice between "dogs" or "cats" before viewing the visualization. The study validated "the logical assumption

that people are more interested in the visualization when the data aligns with their interests" (Campbell & Offenhuber, p. 81). In this context, Luccioni et al. (2021) can be reexamined as an example. This AI-visualization approach adeptly amalgamates various elements: By permitting users to select a particular location, as already mentioned, the creators establish spatial proximity and thereby foster a connection and pertinence. Additionally, this act of selection amplifies the viewer's sense of subjective significance and fortifies the personal bond with the location. Furthermore, the visualizations incorporate future projections, rendering the selected locality 50 years into the future, and in doing so, introducing temporal proximity. This temporal aspect intensifies emotional engagement and adds context. Lastly, combining these connective circumstances culminates in what George Campbell characterizes as "the most powerful" force: interest (p. 89). By incorporating these factors, Luccioni et al. stimulated a certain level of interest in viewers, encouraging them to engage closely with the narrative of the visualization on climate change.

After considering the seven circumstances and their relationship with pathos in data visualization, this thesis has addressed its principal aspects and objectives. Before outlining future research directions and drawing conclusions, it's essential to recognize that, given the thesis' emphasis on comparative literature, the discourse on data storytelling cannot and should not be neglected.

12 Data storytelling: telling a story with data?

In today's data-driven world, being able to tell stories with data is becoming increasingly important. To be rhetorically effective, a data story should contain elements of the unexpected, as any good story should. This unexpected twist seizes the audience's attention and becomes an indispensable aspect of an effective story. This element of surprise captures the interest of the viewer, making it an essential component of a "good" story. When a story deviates from expectations, curiosity is sparked. The unexpected nature of the story prompts a search for answers. As the story progresses, new questions emerge, creating a sense of intrigue and a de-

sire for resolution. In essence, the most captivating stories are those that maintain the reader's engagement until the very end (Matei & Hunter 2021, p. 314). For example, the presentation of research findings in biomedical science often involves complex statistical plots and sophisticated data visualizations. However, these visual representations can be difficult to understand for individuals without a scientific background, including experts from other fields. To improve knowledge dissemination, scientists should focus on improving the communication of their findings to the public (Botsis et al. 2020). Data storytelling can be one way to transform scientific data into narratives that are comprehensible and captivating for a broader audience. By utilizing data storytelling methods, scientists can bridge the gap between technical data and public understanding, thereby increasing the reach and dissemination of their findings. However, it is important to remember, when using storytelling in the context of science: "May the gods of statistics be mollified: the more radically a story violates common assumptions, the better the story" (Matei & Hunter 2021, p. 318). This leads to the next section, namely insofar can science be seen as a form of storytelling, and what does this mean exactly?

12.1 Science as a form of storytelling

In contemporary society, scientists assume a crucial function in interacting with and informing the public regarding their research endeavors. Storytelling is increasingly recognized as a versatile instrument applicable across diverse domains, including but not limited to, advancing entrepreneurial ventures, stimulating innovation within workplace environments, and boosting leadership qualities within corporate settings. Narratives, especially those infused with personal elements, possess a unique ability to facilitate understanding, showcase peculiarities, and create a clear and engaging picture of the past, present, and future (Suzuki et al. 2018, p. 9468). Matei & Hunter (2021) advocate for conceptualizing science as a form of storytelling because it facilitates discovery and questions widely held assumptions. It surpasses traditional storytelling in its ability to consistently offer novel and unexpected explanations. Scientists trained to adopt a narrative mindset can become adept at scientific storytelling. Meaningful science aims to provide unexpected answers to questions about the observable world. It replaces false causal

relationships with new and unexpected ones. Scientific knowledge often contradicts common sense and established beliefs (ibid., pp. 315-316).

Data storytelling involves challenging assumptions about cause and effect by using quantitative analysis. Establishing causality is complex, as correlation does not necessarily entail causation. To assert causality, it is imperative to trace variables over time, ensuring that the cause predates the effect. Data storytelling requires rigor and meeting criteria like controlling for other factors and showing significant effects. Effective science communication goes beyond simply presenting scientific facts to the general public. It involves a complex system that encompasses various factors, such as content, format, communicators, audiences, channels, and social context. This higher standard aims to ensure that data narratives align with scientific inquiry. The goal is to blend quantitative analysis with storytelling instead of creating a divide. Data-driven storytelling should prioritize data, rigor, and accuracy while following data analysis principles. Ultimately, impactful stories challenge common assumptions (Matei & Hunter 2021, p. 318; Martinez-Conde & Macknik 2017, p. 8129). Science represents a perpetual narrative of inquiry and reassessment. Its essence lies not in the affirmation of known facts but in their constant validation against emerging evidence (Matei & Hunter 2021, pp. 315-316).

12.1.1 Pathos and rhetoric in data storytelling

Visual storytelling strives to communicate information effectively to a target audience. The persuasive elements of ethos, pathos, and logos, as expounded by Aristotle, relate intrinsically to storytelling: they represent the communicator's credibility, emotional engagement, and logical argumentation, respectively. Ethos necessitates a clear presentation of findings and reliable sources. Pathos requires an understanding of the audience and the incorporation of components that stir emotions. Logos involves constructing convincing arguments supported by transparent and reliable data. According to experts and theories, achieving balance among these components is essential for successful communication, ensuring factual transmission without overshadowing critical details or personal sentiments (Botsis et al. 2020). In 2007 first attempts were made to introduce students to visual rhetoric beyond document design, discussing persua-

sion and traditional rhetorical devices such as logos, ethos, and pathos can be effective. While students may be familiar with these devices in written text, they may struggle to identify them in images and understand how visual elements contribute to their rhetorical function. By analyzing Macbeth posters, the application of semiotic and rhetorical theory to create persuasive visual rhetoric was "based on 10 figures of speech, sorted into four rhetorical figures or functions" (Amare & Manning 2007, p. 67). Another 2020 research examined the impact of visual narrative techniques through different design approaches in their study. In the first design called "empathy", fictional personas narrate their personal migration journeys in a sequential fashion accompanied by textual descriptions, while visual graphics portray the migration motives and situations in the UK. The objective was to render abstract data tangible and foster an emotional bond with the audience. The second design called "structure" offered a narrative with a systematic framework, utilizing a third-person narrative and focusing on collective descriptions of migrant groups, structured across various themes and interspersed with interactive quiz elements. Both designs were aimed at engaging the viewers and deepening their comprehension of the data. The study found that testing isolated aspects of visual-narrative techniques out of context may reduce the relevance of the results. It also noted that there were small or unexpected effects when testing different visual-narrative techniques or visual communication modes about attitudes toward immigration. The subjective nature of visual narratives made it challenging to quantify and generalize the effects observed in the experimental setup. Visual narratives are subjective, leading to different interpretations and narratives based on the same data. This flexibility is advantageous for designers but makes it difficult to quantify effects and generalize results in experimental setups (Liem et al. 2020).

Given the challenge of quantifying effects and generalizing results in experimental setups (Liem et al. 2020), a reconsideration of communication may be beneficial, as advocated by Sundin et al. (2018), who propose information presentation through storytelling. They suggest that such a holistic approach significantly increases the probability that the audience will not only grasp the facts but will also react and act based on the imparted knowledge. Utilizing narratives in scientific communication can amplify engagement by merging logical reasoning

(logos) with the emotional experiences of the audience (pathos). Nevertheless, the incorporation of storytelling in evidence synthesis, especially within environmental management and conservation, remains underemployed. Weaving together knowledge from reports and briefs into a cohesive and resonant narrative can foster a common understanding and inspire stakeholders to recognize opportunities for engagement and proactive measures (Sundin et al. 2018). To form a good story, each component must be grounded in fact, explicitly articulated, and logically interconnected. In crafting the narrative and selecting its elements, all three principles (ethos, logos, and pathos) ought to be considered. However, when disseminating scientific findings, it is crucial to stick to the facts, clarify critical details, and avoid the emotions of the narrator (Botsis et al. 2020). In conclusion, the adoption of data storytelling represents a valuable approach to conveying complex information. By integrating narratives and visual representations, data storytellers can elicit empathy, compassion, and a personal connection to the data presented. This method offers an effective means of enhancing understanding and engagement with data across various fields.

13 Implications

Certainly, the techniques based on George Campbell's seven circumstances only encapsulate a fraction of the current possibilities for using pathos in data visualizations. Existing research has shown, that there is increasing interest in this topic. Lee-Robins & Adar (2022) explore both affective learning and pathos techniques in data vis and have recognized those design elements, in particular, are likely to capture the audience's attention, arouse emotions, and thus create a more engaging experience (Lee-Robbins & Adar 2022). Additionally, they enumerate other methods for eliciting pathos, some of which were only partially mentioned in this thesis; hence, certain worth-noting techniques include visual imagery embellishments or art (e.g., Bateman et al. 2010; Lan et al. 2021), narratives or stories (e.g., Kostelnick 2016; Packer et al. 2012, Hullman & Diakopoulos 2011, Lee et al. 2013), sensitive or sensory experiences (e.g., Elli et al. 2020), immersive data visualizations (e.g., Ivanov et al. 2019; Romat et al. 2020; Donalek

et al. 2014) and animation (e.g., Lan et al. 2022a). Although extensive research has been conducted, there is still a chance of missing relevant studies due to differing keyword results across various scientific disciplines. While this thesis aims to bring together a wide range of techniques, theories, and research findings, its concise nature and the vast array of rhetorical framing approaches specific to visualizations inherently limit its scope. Therefore, its goal is to provide a representative sample of the numerous techniques and theoretical concepts present in the field.

13.1 Discussion

Drawing from insights in literary studies, the incorporation of pathos into data visualizations stems from established traditions in rhetoric and narrative found in literature. Literature has long recognized the power of pathos in evoking emotions and engaging readers. By applying this concept to data visualizations, this thesis bridges the gap between the analytical and creative realms, fostering an interdisciplinary approach that can enrich both fields. This interdisciplinary collaboration opens up new opportunities for exchange and synergy among experts in data visualization, literature, rhetoric, and related fields. By leveraging insights from literary studies, it is possible to further explore the nuanced techniques employed in storytelling, as well as emotional resonance, and to apply them to the visual representation of data. This cross-pollination of ideas and methodologies can lead to more sophisticated data visualizations enriched with pathos strategies that resonate deeply with viewers. Such collaborative efforts offer diverse perspectives and techniques for crafting engaging visual narratives. This interdisciplinary discourse can spark innovative approaches and generate insights that transcend traditional disciplinary boundaries, ultimately pushing the boundaries of both fields and enriching our understanding of the potential of pathos in data visualization. While George Campbell's framework provides a foundational strategy for incorporating pathos into data visualizations, it's important to recognize that it represents only a fraction of the potential within this field. Building on previous research, such as Lee-Robbins and Adar's (2022) exploration of affective learning and pathos in data visualizations, this thesis highlights the imperative of leveraging insights and method-

ologies offered by comparative literature to attain a comprehensive understanding of visualized data and how it is received. By focusing on the theoretical aspects of pathos in data visualizations, this thesis identified both limitations and opportunities for future research in this area. By using Campbell's circumstances as a starting point and addressing these research gaps, we can further enhance the effectiveness of pathos in data visualization. This thesis has analyzed the foundational elements of data visualization, emphasizing the strategic utilization of rhetoric as a component becoming more and more important. It stresses the importance of being attentive to inadvertent manipulation and recognizing the distinct capacity of visualizations to mold, stimulate, and validate cognitive and emotional reactions. However, it is essential to consider the perspective of the viewer in these interactions. If the intended meaning of a visualization diverges from the viewer's interpretations, there's a heightened risk of rejecting the message despite its emotional impact. It's an ironic twist that emotional persuasion could potentially widen the gap between intended and received messages, as discussed by Kjeldsen (2021).

13.2 Limitations and future work

The investigation of pathos in data visualizations within this thesis serves as an initial exploration of its potential applications. Pathos, as an emotional appeal, holds significance across diverse media platforms, encompassing literature, film, and advertising. Concepts such as inter- and transmediality, which examine the interplay between different forms of media, offer insights into emotional appeals across various platforms. Adopting an interdisciplinary approach informed by these concepts can deepen the understanding of the emotional aspects of data visualization, resulting in more resonant and empathetic visual narratives. This approach is aligned with the utilization of narrative strategies discussed in the thesis. Narrative visualization employs different rhetorical devices to weave a story with visual data, an idea referred to as "visualization rhetoric." This form of "visualization rhetoric", as an analytical framework, is similar to data storytelling and should therefore also be mentioned in this thesis. Framing effects observed in narrative visualizations have been noted to enhance the engagement levels of viewers. Additionally, user interaction within such visualizations allows for greater control over

the insights generated (Hullman & Diakopoulos 2011). It is noteworthy that while the majority of studies surveyed herein employed techniques congruent with Campbell's Circumstances, only a minority of them were explicitly aimed at measuring whether pathos or empathetic emotions were created. Future research should delve into several key inquiries: Firstly, what specific emotional responses are elicited by proximity strategies or framing effects within data visualization? Secondly, can these emotional reactions be reliably quantified? Moreover, it is imperative to ascertain whether the experience of empathetic emotions precipitates discernible alterations in viewer behavior, and if so, the nature and extent of such behavioral shifts. However, there are extensive opportunities for future inquiries. Research could integrate findings from data visualization, exploring how emotional appeals, aesthetics, and visual rhetoric in different media evoke empathetic responses. Insights into emotional appeals in literature, film, and advertising could elucidate their effects on audience comprehension, memory, decision-making, and behavior. Furthermore, the role of aesthetics in storytelling across different media could be investigated, examining how visual elements contribute to user engagement and emotional resonance. Also, it would be interesting to conduct longitudinal studies to assess the impact of empathetic storytelling techniques on behavioral change and memorability. By tracking audience responses over time, researchers could gain a deeper understanding of how affective narratives shape perceptions and actions. Lastly, future research could also focus on exploring the theoretical underpinnings of affective storytelling techniques across different media forms. By analyzing literary texts, films, and other cultural artifacts, new theoretical frameworks could be developed to understand how emotions are conveyed and experienced through narrative.

14 Conclusion

As the rhetorical approach coined by Aristotle is a rhetoric of persuasion, the question that arises is: what would be the next step? Persuasion often fosters a desire for action (Trope et al. 2007). If a framing effect leads to the fact that the rate of organ donations in Austria in 2003 was almost 100%, while in Germany it was just under 12% (Kahneman 2012, p. 373), then this

means that the methods presented in this thesis can have a real-world impact. Moreover, numbers gain significance only when they are comprehensible to the majority, not solely to experts. Since numbers are not the natural dialect of humans, Heath emphasizes the imperative for those working with quantitative data to translate and personalize this information. Cognitive retention tends to be higher when new information aligns with pre-existing mental frameworks. For instance, if numerical data appears initially unrelated, presenting it in a manner that resonates with personal experiences can stimulate contemplation regarding its relevance and potential impact on one's life (Heath 2022, p. 62). While the use of affective and emotional appeals to alter viewer behavior is commendable, it is argued that the primary focus should be placed on ensuring a thorough comprehension of the visualized data. Recalling Benjamin Bloom's taxonomy of learning and teaching highlights the importance of comprehension (Lee-Robbins & Adar 2022). Achieving behavior change through data visualization requires a thorough understanding of the data's significance by individuals. The potential of pathos to evoke empathy and emotional responses enhances the comprehensibility and impact of data visualizations, as evidenced by the six facets of understanding (Wiggins & McTighe, 2005, pp. 82-105). Consequently, it is essential to prioritize efforts to enhance comprehension of visualized data before considering behavioral modification strategies.

Essentially, this master thesis provides valuable perspectives, including the following insights:

- **Clarity in terminology:** This research defines the different terms aesthetics, rhetoric, and pathos and puts them into the context of data visualizations. This clarity is a first step for fostering a shared understanding within the field, reducing ambiguity, and enabling effective communication among researchers, designers, and practitioners.

- **Historical roots of rhetoric:** Tracing rhetorical techniques, especially pathos, back to Aristotle, this thesis highlights the historical context to guide effective use in contemporary data communication. By exploring George Campbell's influential rhetorical framework, the lasting relevance of historical theories can be analyzed.

- **Ubiquity of emotions in communication:** Recognizing emotions as part of communication, it becomes apparent that people naturally infuse emotions into data visualization. Often, this occurs unknowingly, highlighting the need for a conscious understanding to enhance the intentional and effective use of emotions in data visualization design.
- **Emotional appeal can be beneficial for data visualizations:** This research underscores the significance of emotional appeal (pathos) in data visualization, asserting that emotions are essential for connecting, understanding, and engaging with complex information.
- **Ethical and effective use:** Addressing the neglect of emotional appeals, this research poses a central question on how understanding the dynamics of emotion, rhetoric, and aesthetics can improve ethical and effective visual rhetoric in diverse contexts.
- **Aesthetics influences usability and sense-making:** This thesis shows the link between aesthetics and data visualization effectiveness, suggesting that attractive visuals contribute to sense-making and enhance usability.

The role of emotions in data articulation and processing, particularly in data visualizations, has been thoroughly supported in this thesis. However, concerns persist regarding intentionally evoking emotions through visualizations and the potential risks associated with this, such as the potential for biased perception of ostensibly objective data. Furthermore, beyond the techniques based on George Campbell's seven circumstances, additional strategies, such as data storytelling, have been identified as effective in enhancing audience engagement with data (Matei & Hunter 2021; Neifer et al. 2020). Stories in particular hold enormous potential to captivate people, whether they contain numbers or not (Matei & Hunter 2021). When numbers are woven into narratives that resonate emotionally, they stand a better chance of being retained and, in the best case motivating change (Heath & Abrahams 2022). Should this not be among the goals of data visualizations? To represent numbers and data not merely visually but to translate them into terms comprehensible to the layperson; to communicate such that it fosters a link between individuals and data that avoids "statistical numbing" without descending into mere

embellishment. This thesis aims to provide a comprehensive overview and insightful discussion. Through an analysis of existing theoretical literature coupled with empirical research, this interdisciplinary approach serves as a robust foundation for the exploration of new ideas and perspectives. It offers a novel framework for future studies and papers to build upon. While it is imperative to recognize that the notion of empathetic emotions cannot be indiscriminately transplanted from the arts and culture to the field of statistical data, this thesis tries to bridge the gap between different academic areas. Uniting knowledge from various disciplines, including social sciences, economics, humanities, data visualization, and literary studies, this work introduces a new approach aimed at renewing data visualization practices. By adeptly applying pathos techniques, data visualizations can emerge as potent tools that not only fortify understanding and memorability but also heighten audience engagement. Integrating elements of pathos into data visualizations, such as color, imagery, personal anecdotes, and emotive appeals, a strong emotional connection can be forged. The cited studies provide evidence supporting the notion that proximity techniques have a notable capacity to evoke pathos within data visualizations. Another aspect of this thesis is data storytelling, which uses narrative techniques to convey information and insights through data visualizations. This approach transcends mere statistical presentation by crafting narratives that evoke emotions and deeply engage the audience. This strategic use of pathos enhances the dynamism, tangibility, and influence of data visualizations, facilitating a deeper comprehension and resonance with the data. By leveraging pathos, data visualizations bridge the gap between their analytical nature and the human aspect of understanding and interpretation, thereby improving their effectiveness in communication. The aesthetic focus in the visualization community has been influenced by Tufte, emphasizing minimalism and clarity. However, there is a recent shift in focus towards a greater consideration of rhetorical elements and the communicative aspect of data visualizations. This approach to incorporating literature in this paper is novel, as this thesis examines not only the developments over the past two or twenty years but also takes a look further into history, shedding light on roots that extend back over two hundred or even two thousand years. To the best of my knowledge, this work is the first to provide definitions of pathos and rhetoric (as a holistic concept) embedded

in the aesthetic-rhetorical context of data visualization. In doing so, this paper aims for a more nuanced understanding of how emotional and persuasive elements are intertwined with data visualizations. This can enrich the discourse surrounding data communication and empower practitioners to create more effective and affecting visualizations. Moreover, this focus and understanding of rhetorical aspects can improve interpretation and decision-making when people use visualizations. This work synthesizes research from a variety of academic disciplines and prepares it terminologically, intending to operationalize it in further empirical work on visual data communication. Understanding the historical background and evolution of rhetorical, aesthetic, and affective elements in data visualizations is significant as it offers insights into past successes and failures. It shows the interwoven complexity of the concepts but also demonstrates the legitimacy of using rhetorical devices in scientific communication, in general, and data visualizations, in particular, to reach wider audiences more effectively. Through continued exploration and refinement, we can harness the full potential of data visualization as a powerful, rhetorical tool for communication and knowledge dissemination within diverse fields and contexts, just like Aristotle proposed.

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