

The Art and Beauty of Informing: Subjective Information, *Vorstellung*, and Aesthetics in Information Visualization

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Abstract

This paper differentiates objective from subjective views of information, emphasizing the role of human intentionality and creativity in the informing process. Combining Schopenhauer’s aesthetics with the subjective theory of information, we reconceive data representation as an art form. Using a case study of Tableau’s best practices, we show how intentional creativity can transform ‘objective data’ into meaningful and aesthetic visualizations, fostering deep emotions and profound insights. This approach can reconcile environmental complexity and ambiguity, thereby enriching the human experience. However, it carries the risk of seduction through beautiful, but misleading, information, necessitating a shift in focus from useful to responsible data representation.

Keywords: Information, representation, art, creativity, visualization, data science.

1. Introduction

What do Newton, Napoleon, and Beethoven have in common? And how do they differ from Mark Zuckerberg and Sam Altman?

Newton’s division of visible light into seven spectral constituents shaped color theory and cultural narratives, like children’s songs about rainbows. His *intentional* choice of seven, a number with mystical significance, demonstrates how language and symbolism influence our conception of the world (Berlin & Kay 1991 Fig.1).



Figure 1. Newton’s Color Wheel

For example, the Homeric reference to a ‘wine-dark sea’ is often attributed to the absence of a concept for ‘blue’ in ancient Greek

Minard’s map of Napoleon’s Russian campaign is celebrated as a pinnacle of statistical graphics. The map’s flow lines, which depict the shrinking of the Grande Armée, combine data and narrative to represent a complex historical event with striking clarity. Minard *intentionally* invited readers to interpret the visual narrative themselves (Kraak 2021, Fig.2).

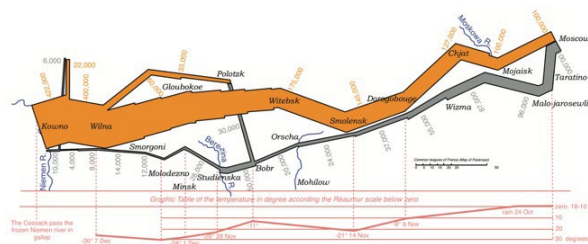


Figure 2. Minard’s Map (Translated)

Beethoven’s unfinished Tenth Symphony saw a new form of completion in 2021 through generative AI, trained on his sketches. The AI showed glimpses of incidental creativity but fell short of *intentional* creativity, lacking Beethoven’s non-linear thinking, contextual decision-making, unusual choices, and iterative refinement (Brandt 2023, Fig.3).

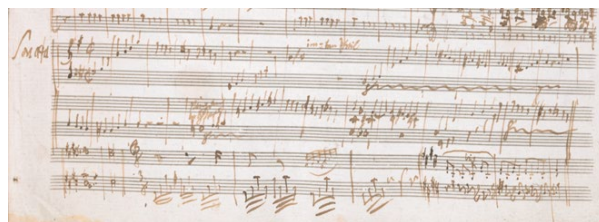


Figure 3. Sketch of Beethoven’s Unfinished Tenth.

Today, the world is oversaturated with ‘big data’. Not long ago, we lived in the ‘information age’, and now ‘artificial superintelligence’ looms. If data were truly ‘the new oil’ and AI had surpassed human intelligence,

why do we see fewer creations of aesthetic and intellectual significance akin to Newton's theories, Minard's maps, or Beethoven's symphonies. Why is there less beauty rather than more?

The issue is not the lack of information but how we think about information. Beyond superficial rhetoric, the true meaning of information remains elusive. Without a clear understanding of information, we oscillate between seeking more of it and feeling overwhelmed by its abundance. This situation is unsettling because our simplistic intuitions about data and information no longer suffice. What is needed is a method to transform data into helpful information.

We maintain that the process of transforming data into information is more of an art than a science. There is no cookie-cutter for it. However, just as there are principles of composition in music, there are principles of composition for representing data. For example, tastes in music differ vastly, but basic harmonic principles, such as moving through the circle of fifths, must be followed for any composition to 'sound good'. So, what is needed to compose a good data representation? Our central proposition is that:

The inherent ambiguity and complexity of our environment can be reconciled by informing aesthetically through intentional creativity.

Informing in this proposition derives from the subjective theory of information (McKinney & Yoos 2019), and is complemented by Schopenhauer's ideas of representation and aesthetics (Ciriello 2024). Our contribution is a fusion of these theoretical viewpoints into a more complete understanding of what information is, highlighting the factors that make information not only useful but helpful and, ultimately, beautiful. Our intent is to suggest how creators of data representations and interpreters of information can make their work more aesthetic.

The key difference between Newton, Napoleon (or Minard), and Beethoven on one side, and Zuckerberg and Altman on the other, lies in their conception of information. Newton, Napoleon, and Beethoven were intentional in their processes, aiming to create data representations that were deliberately aesthetic and beautiful, inspiring people to think differently about the world. Their work involved a deep appreciation of the principles of composition and a deliberate creativity that transcended mere functionality. In contrast, Zuckerberg and Altman view information as objective, as data, a resource to be harvested for utility, profit, and efficiency. Their focus is on extracting data for commercial gain, often at the expense of the nuanced intentionality and beauty that characterized the works of their historical counterparts. Facebook's business model relies on vast data collection for targeted ads, emphasizing data's role in driving engagement and

profit. The Cambridge Analytica scandal exemplifies how this approach can prioritize profit over privacy, highlighting an instrumental view of information. Similarly, Altman, as CEO of OpenAI, focuses on using AI to maximize efficiency and scale, often prioritizing utility over ethical considerations about the nature of informing.

Our goal is not to diminish the technical achievements of Zuckerberg and Altman but to encourage critical reflection on the broader implications of their approaches. Today's tech entrepreneurs are merely perfecting the dispassionate craft of stripping objective information of its aesthetic value – ignoring the opportunity, the hope for beauty – which we are all complicit in. This divergence highlights the need to return to a more deliberate and creative approach to data representation, emphasizing aesthetics and intentionality to inspire beautiful interpretation.

Acknowledging the complementarity of utilitarian and aesthetic views of information is essential for a holistic understanding of its value. Newton, Minard, and Beethoven exemplified how utilitarian purposes can coexist with aesthetic intentionality—Newton's scientific rigor, Minard's public service, and Beethoven's commissioned work were all driven by functional needs yet deeply infused with creativity and beauty. Similarly, while the utilitarian focus of contemporary figures like Zuckerberg and Altman emphasizes efficiency and functionality, their approach can also benefit from an aesthetic dimension, as the creation of large-scale digital systems requires creativity.

There are two steps to informing, each with the potential for beauty. First, a composer (such as Newton, Minard, or Beethoven) transforms data into a form, a representation, a visualization. This process of *in-form-ation* involves combining text and context to create beautiful subjective information for themselves. At first, what the composer produces is not information for others, but data. The interpreter then takes this data, this representation and places it into their own context, creating a unique interpretation and thereby transforming it into their own, potentially beautiful, information. Both the composer and the interpreter can create beauty, but it is not the same beauty. While Zuckerberg and Altman do not compose beauty or make it easy for the interpreter, the interpreter can still take their data, place it in their context, and occasionally create beauty for themselves.

We proceed by elaborating the conceptual foundations of our proposition, followed by a case study of Tableau to contextualize its workings in a real-life setting. We then articulate our contribution and sum up key takeaways in the conclusion.

2. Conceptual Foundations

As a theoretical bedrock for our proposition, this section introduces the subjective theory of information as well as Schopenhauer's aesthetics.

2.1. Subjective Theory of Information

The subjective theory of information, articulated by McKinney and Yoos (2019), maintains that information is not an objective, external resource but is dynamically created through a system's continuous adaptation to an uncertain environment. This perspective contrasts sharply with conventional, objectivist views that treat information as static and observer independent (Kettinger & Li 2010; Mingers & Standing 2018). According to the subjective theory, information emerges from perceived differences within a system—whether these systems are organisms, individuals, or organizations. These differences are not predefined or external; they are identified and interpreted internally.

The subjective theory differentiates information from data (which is often equated with objective information), emphasizing that while data is static and external, information is dynamic and internal. Data can be stored and shared, but information is internal and unique to each individual, shaped by context and personal significance (McKinney & Boell 2023). We adopt this language, a visualization, like all data representations, is external and is objective data, or data that is represented.

This theory highlights that information emerges from the meaningful interpretation of data, driven by differences that matter to the interpreter. It aligns with Weick's (1995) view of an inherently ambiguous environment that necessarily supports multiple interpretations. In this view, uncertainty is not a temporary condition but a persistent state reflecting an environment that is certainly uncertain.

This conceptualization draws on Bateson's (1987, p. 287) definition of information as "a difference which makes a difference", with *criteria* serving as dimensions that determine which differences make a difference to the interpreter. These criteria, learned through experience and education, help individuals interpret data into meaningful information by focusing on relevant distinctions. Higher-level meta criteria further refine this process, allowing for the recursive application of criteria to themselves, thus facilitating informed decision-making (McKinney & Yoos 2019).

The subjective theory of information extends the notion of conception beyond a passive, one-time process to depict a system's ongoing, active adaptation to complex and evolving landscapes (Gibson 1979; Heft 2003; Merleau-Ponty & Smith 1979). Individuals and

systems do not merely process information mechanically; instead, they are embodied subjects engaged with their existence. Conception and perception often occur simultaneously, reflecting a dual process of receiving and creating information within an uncertain context. As McKinney and Yoos (2019, p. 359) succinctly put it, "Information is conceived from difference. Thus, differences are perceived; information is conceived." As individuals perceive and conceive, they create a cybernetic loop with their environment, continually altering both themselves and their surroundings. They generate information to change themselves, then perceive their environment anew, creating information and perpetuating the cycle.

This process of conception is influenced by experiences, education, and expectations (Berger & Luckmann 1966; Lakoff 1987). This idea emphasizes the agency of the system in shaping its reality in response to uncertain environments, promoting self-creation based on internal perceptions rather than external stimuli (Luhmann 1995; Maturana & Varela 1980). It challenges the conventional view of the brain as merely an 'information processor', highlighting adaptability through self-driven change (Maturana & Varela 1987). Conception captures the essence of a system's inherent adaptability and capacity for self-driven renewal, underscoring the active role of the observer in the creation of meaningful information.

When an individual conceives subjective information, they are initiating the process of making meaning and making sense of the world. *Sensemaking*, as described by Weick (1995), is a broader process that helps individuals comprehend ongoing, equivocal, and complex phenomena. It extends beyond subjective informing by addressing organization, social behavior, and meaning. Subjective information can be considered a precursor to sensemaking, where the individual uses "differences that make a difference" to create meaning.

Context, which is central to both subjective information and sensemaking, has roots in philosophy, linguistics, and law. Definitions of context often include the physical and conceptual states of interest to a particular participant, as well as factors such as location, companions, and available resources (Schilit & Theimer 1994); Pascoe 1998). Context influences what is perceived and the criteria for conception.

Having described subjective information in general, in visualizations, it means the interpreter informs themselves. The creator of the visualization arranges the data, represents the data, then the individual conceives differences from it. The individual is encouraged to use beauty as a criterion, and the creator is encouraged to anticipate the interpretation and help make that interpretation more beautiful. Two actors, the art store

owner and the artist, the grocer and the chef, with the goal of more beautiful visualization interpretation.

Recognizing that subjective information involves participative and active interpretation, the outlook of an individual becomes more curious, more attentive to differences, more willing to seek beauty, and more responsible for the process of *Vorstellung*, which we describe next.

2.2. Schopenhauer's Aesthetics

German philosopher Arthur Schopenhauer (1788 – 1860) provides a profound and complementary insight into the subjective nature of information, particularly through his ideas on aesthetics.

Resonating with the subjective theory of information, Schopenhauer's philosophy posits that all phenomena are necessarily subjective; we do not experience objects as they are, but only as they appear to us. This perspective builds on Immanuel Kant's distinction between the thing-in-itself (*noumenon*) and its appearance (*phenomenon*) (Ciriello 2024). Drawing on this distinction, Schopenhauer argues that "the objective world as we know it does not belong to the true being of things-in-themselves, but is its mere phenomenon, conditioned by those very forms that lie a priori in the human intellect (i.e., the brain); hence the world cannot contain anything but phenomena" (Schopenhauer 1859 §11). This radically subjectivist view aligns with George Berkeley's subjective idealism and Søren Kierkegaard's subjective existentialism (Berkeley & Krauth 1878; Solomon 1988).

Schopenhauer encapsulates this idea in opening his main book with the aphorism "Die Welt ist meine Vorstellung" (the world is my representation). The German term *Vorstellung*, commonly translated as 'representation,' has diverse connotations such as idea, appearance, performance, and presentation. It encompasses both the idea of objects and data being presented to us and our active interpretation, our conception and engagement, with them (Schopenhauer 1851, 1859). Thus, reducing *Vorstellung* to mere 'representation' misses Schopenhauer's dual notion of what is 'set before' a cognizant subject as its object, and the presentational activity of the subject therein engaged (Carus & Aquila 2010). For a more accurate understanding, *Vorstellung* can be considered as 'performance'—the world appears as a performance of objects in the theater of our mind. This dual meaning underscores the active role of the interpreter in the creation and appreciation of information.

As an illustration of *Vorstellung's* performative aspects, consider how we do not simply receive musical notes when we listen to music; rather, we perform the music, it comes alive in our mind's theater. When music

comes from an unfamiliar culture or genre, we often find it harder to appreciate its beauty because we lack the criteria to contextualize it. Thus, we must engage more purposefully and forcefully in its *Vorstellung* to discern the foreign music's aesthetic value. This requires openness, effort, and willingness to learn new criteria for evaluation. In much the same way, subjective information (unlike data) cannot be simply transmitted to us; we must engage with it, animate it, perform it in the theatre of our minds, applying appropriate criteria to appreciate its beauty and at times learning new criteria where we fail to do so.

Schopenhauer's concept of *Vorstellung* guards against the notion that we can 'imagine' or 'dream up' the world as we please. Instead, representations manifest empirically in a strictly causal way. This approach extends Kantian rationalism by asserting that *Wille*, or will, can be experienced through mindful contemplation and introspection, allowing us to recognize our nature as servants to *Wille*, despite its unrecognizability through sensory perception alone (Schopenhauer 1859). Schopenhauer's philosophy thus highlights an intelligible freedom of will in that one can experience *Wille* and negate it through the appreciation of art (Schopenhauer 1839). This underscores the idea that information does not correspond to an external, objective state of the world but emerges from the interaction between the environment and the informer's desires, perceptions, interpretations, and capabilities.

Schopenhauer's aesthetics provide a pathway to relief from the suffering induced by servitude to *Wille*. Through art appreciation, we can temporarily lose ourselves in a contemplative state of pure perception, which Schopenhauer calls melancholy (Schopenhauer 1859 §16). In this state, individuals can appreciate phenomena in their pure form, without being influenced by personal desires or motives (Magee 1997; Safranski 1991; Shapshay 2021). Schopenhauer suggests that genuine art offers an authentic answer to the question 'what is life?' that transcends reason. By embracing Schopenhauer's aesthetics, we can come to recognize that information not only serves functional purposes but also contributes to human flourishing through beauty and introspection.

3. Case Study: Visualization with Tableau

This section critically examines how Tableau's best practices for visualization align with our proposition of representing data aesthetically through intentional creativity.

3.1. Traditional Challenges of Visualization

Visualization, in the conventional context of data science, involves transforming abstract data into a graphical form that can be easily interpreted and understood by a human interpreter. Traditional definitions emphasize visualization as a tool to ‘gain insight’ by leveraging the human visual system’s powerful capabilities (Card et al. 1999; McCormick 1987). It is seen as a method of converting symbolic representations into geometric ones, enhancing the process of scientific discovery by making the unseen visible (McCormick 1987; Tufte & Robins 1997).

However, these conventional views often treat visualization as a passive process, focusing primarily on amplifying cognition, revealing hidden structures, and answering predefined questions (Chen et al. 2014). In this view, a composer of a visualization merely generates a graphical form that is given to an interpreter or audience. This perspective tends to overlook the subjective and creative aspects of visualization for both the composer and interpreter. The composer must select, interpret, and present the data, and the interpreter must make their own information from the visualization. Thus, a more comprehensive understanding of visualization should include its intentionality and aesthetics for both the composer and interpreter.

For visualization analysts, the overwhelming volume of data poses a significant challenge. They must decide what to show, what to ignore, how to highlight important aspects, and how to respond to various questions. This process can induce anxiety, driven by the fear of missing key messages in the data and the concern that consumers of their visualizations might not understand their intentions.

Consumers of visualizations face their own set of challenges. The data presented can be interpreted in multiple ways, leading to concerns about missing the intended message(s) or misinterpreting the analysis. Traditional theories of information as objective often suggest methods to mitigate these issues by improving the clarity and precision of visualizations. However, these approaches tend to ignore the intractable ambiguity, the pernicious under-specification of the data, the subjectivity of the information, and the potential for creativity. For instance, whereas mainstream Western science views ambiguity primarily as negative, as in ‘insufficiently clear’, some have recognized that the inherent ambiguity of data and language can be a fruitful source of improvisation, curiosity, creativity, and humility (McKinney & Shaffer 2023).

3.2. Tableau’s Best Practices for Visualization

Tableau, a widely used visualization software, provides a set of best practices that can be examined through the lens of our proposition on aesthetic data representation. These practices help the composer make aesthetic visualizations, a beautiful representation that their interpreters can take as data and transform into their own uniquely beautiful information in the theater of their mind. Succinctly, the composer composes a visualization they anticipate interpreters can make beautiful for themselves.

While Tableau’s best practices are designed to engage audiences, discover insights, and derive answers through clear visualizations (Tableau Blueprint 2024), its commercial objectives (as a software owned by billion-dollar multinational Salesforce) introduces trade-offs for how data is represented. Tableau’s guidelines focus on enhancing the visual appeal and clarity of data presentations, aiming to balance functionality with aesthetics. These best practices are intended to guide the composer in creating visualizations that are not only informative but also engaging and aesthetically pleasing. However, it is essential to critically evaluate these practices within the context of their underlying commercial objectives and the broader implications for how data is represented. Tableau’s best practices are specified as follows (Tableau Blueprint 2024):

Audience and Purpose: Effective visualizations should be designed with a clear purpose and be tailored to the audience’s needs. The focus on audience understanding ensures that the level of detail is appropriate, such as presenting aggregated data to executives rather than row-level transactions (Tableau Blueprint 2024).

Context and Storytelling: Tableau emphasizes the importance of context and storytelling, suggesting that visualizations should be engaging and impactful. This approach seeks to evoke emotional responses, making data more relatable and memorable (Tableau Blueprint 2024), though this carries the risk of oversimplification or manipulation through seductively beautiful, but misleading, data.

Chart Choice: The choice of charts (line, bar, heat map, etc.) should be guided by the type of data and the message intended (Tableau Blueprint 2024). While the software offers a variety of chart types, the selection process requires careful consideration to ensure that the visualization is both effective and appropriate for the audience.

Layout and Flow: The layout of a dashboard should guide the reader’s eye through multiple views, telling the story of each insight. A sensible flow and logical arrangement of data are critical for effective dashboards. Design concepts like the Z-layout, white space, and size

variations help in creating a coherent and navigable dashboard (Tableau Blueprint 2024).

Color and Highlighting: The effective use of color in Tableau’s visualizations is vital for drawing attention to specific insights (Tableau Blueprint 2024). However, the choice of colors must be handled carefully to avoid misleading interpretations. Consider how the color red signifies danger in Western culture, happiness in Chinese culture, and mourning in some African cultures.

Interactivity: Interactive elements, such as filters and tooltips, allow users to engage with the data and explore insights independently (Tableau Blueprint 2024). This interactivity can enhance aesthetics, but it also introduces the potential for misinterpretation or even misuse. For instance, tooltips can be used for selective disclosure and manipulative framing, or they can confuse the audience by providing inconsistent or out-of-context data.

Performance and Efficiency: Designing for performance is emphasized in Tableau’s best practices, ensuring that dashboards are responsive and user-friendly (Tableau Blueprint 2024). This focus on efficiency aligns with the software’s commercial objectives but must be balanced with the need for aesthetic and accurate representation of data.

Accessibility: Making visualizations accessible to as many people as possible is essential. Tableau’s commitment to accessibility reflects a broader industry trend toward inclusive design (Tableau Blueprint 2024). Ensuring that visualizations are accessible to all users, including those with disabilities, is an important aspect of responsible data representation.

While Tableau’s best practices contribute to the creation of aesthetically pleasing and effective visualizations, it is important to recognize the potential tensions between aesthetic considerations and the practical demands of data interpretation. The subjective and artistic aspects of visualization, as promoted by Tableau, must be critically assessed to ensure that they serve the broader goal of meaningful data representation, rather than merely enhancing visual appeal for commercial gain.

3.3. Example: Karim Douieb’s Electoral Map

An illustrative example of a visualization’s beautification is Karim Douieb’s redesign of the 2016 US electoral map (Wilson 2020). Douieb, a Belgian data scientist, altered an electoral map tweeted by Lara Trump that depicted vast swathes of land as voting for Donald Trump, rather than representing the population distribution (Figure 4.1).



Figure 4.1. Lara Trump’s Electoral Map Tweet

Douieb’s (2020) composition transformed the electoral map into a more meaningful representation by using circles proportional to the number of votes in each county (Figure 4.2). This visualization highlighted the actual voting patterns, revealing a more nuanced and accurate picture of the electorate. Douieb’s map went viral, not only because it engaged interpreters emotionally and intellectually for those with a similar context. The map conveys a poignant message, a different tune: Land doesn’t vote, people do.

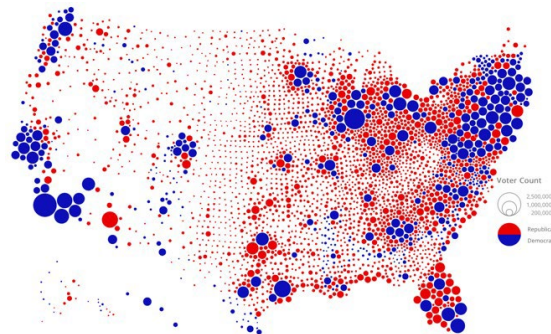


Figure 4.2. First iteration of Douieb’s Map

In a striking case of intentional creativity, Douieb continued to refine his approach to visualizing election data in response to his audience. The second iteration of his map divides each county’s circles into red and blue parts, providing a more nuanced representation of voting patterns, demonstrating that liberal strongholds like New York and Chicago also have conservative bases (Figure 4.3). By transforming the data into a visually striking and aesthetic visualization, Douieb demonstrated intentional creativity in data representation.

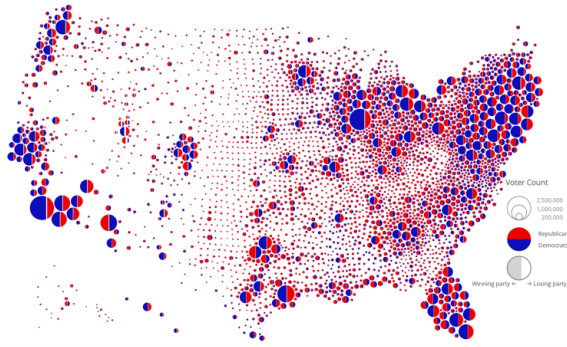


Figure 4.3. Second iteration of Douieb's Map

3.4. Transforming Data into Meaningful and Beautiful Information

The essence of this case study is that the meanings of original data and their visualization are inherently ambiguous and subjective, always requiring a composer and interpreter to interpret and ‘sing’ it to themselves. Creating a visualization is not merely about following best practices but involves making intentional choices that transform data into meaningful and aesthetic information for the creator. This process requires the composer to suggest answers, establish criteria, and engage in a creative dialogue with the audience. The two sides, the composer and the interpreter, both perform the informing.

In Tableau, this transformation is facilitated through its intuitive interface and vast visualization capabilities. Composers can explore data interactively, experiment with different representations of the data, and refine their visualizations based on feedback and insights. This iterative process reflects the jazz-like art of improvisation, where criteria and interpretations co-evolve dynamically.

The creative aspect of visualization involves selecting criteria that influence interpretation and crafting visual representations that are not only functional but also aesthetically pleasing. Beautiful visualizations adhere to principles of wholeness, harmony, form, and surprise, much like a work of art. Tableau supports this artistic endeavor by providing tools and features that enable the creation of visually stunning and effective visualizations. The use of color, shape, and layout can transform a simple data chart into a compelling visual story that resonates with interpreters on an emotional level.

Just as the creation of visualizations can be artistic, so can their interpretation. Interpreters engage with visualizations not just cognitively but also aesthetically, appreciating the beauty and intentionality behind the representation as they make it their own information (their own *Vorstellung*). This approach encourages a more empathetic and reflective interaction with the data,

fostering a deeper understanding and connection. Interpreters are in a cybernetic loop with the visualization, particularly interactive dashboards. They perceive and conceive differences, then pose new questions to the visualization; the performance of a *Vorstellung* is rarely a single act.

Tableau's best practices are often used to create sophisticated, professional, and impressive visualizations. For example, Tableau's Viz Gallery (<https://tableau.com/viz-gallery>) showcases these advanced and complex displays of artistic symbols and intricate backgrounds. While arguably beautiful, these visualizations are complex, difficult to create, and rare, akin to classical music. However, we suggest that best practices can also be used to produce simpler, everyday visualizations that still resonate with smaller audiences.

In summary, Tableau's best practices exemplify our proposition that the inherent ambiguity of our environment can be reconciled by representing data aesthetically through intentional creativity. By embracing both the scientific principles of effective visualization and the artistic aspects of beauty and intentionality, Tableau facilitates the transformation of data into meaningful and beautiful information in the mind of the composer. This beautiful composition can be shared with interpreters who add their own mixture of criteria and create their own, ideally beautiful, *Vorstellung*. Through intentional creativity, both composer and interpreter can navigate the overwhelming data landscape, improve communication, and create meaningful insights.

4. Discussion

Our exploration into the art and beauty of representing data highlights the vital role of subjectivity, *Vorstellung*, and aesthetics in transforming data into meaningful and coherent information. This perspective diverges significantly from traditional objectivist views of information, which often emphasize functionality, clarity, and message delivery at the expense of interpretation, beauty and intentionality. By considering the process of transforming data representation into subjective information as an art form, we propose that beauty serves as a meta criterion that can guide the creation and interpretation of aesthetic visualizations. In the realm of music, beauty differentiates poor and excellent uses of melody, harmony, and rhythm. Similarly, in visualization, beauty can be used to evaluate the composition of variables, trends, patterns, and narratives. Classical conceptions of beauty, as discussed by philosophers such as Aristotle and Plotinus, emphasize the arrangement of integral parts into a coherent whole. This notion is deeply rooted in

Western thought and is reflected in various art forms, including architecture, literature, and music.

According to Aristotle, beauty in a living creature or a whole made up of parts must present a certain order in its arrangement. This principle can be applied to a visualization, where the beauty lies in how well the parts (data points, variables, visual elements) are arranged to form a coherent and harmonious whole, by both the composer and the interpreter. For each, the whole is unique, but the process is the same. Building on this idea, Schopenhauer also emphasized the subjective experience of beauty, suggesting that genuine art can evoke profound emotional responses and profound insights into the nature of existence.

Applying these principles to information, we see that its conception can be performed beautifully. The term *in-form-ation* itself, derived from Latin and Greek roots, suggests a process of forming, molding, and illuminating (Applegate et al. 1999).

When data is transformed into meaningful information in the composition or interpretation of a visualization, beauty reconciles the parts into a coherent whole. This coherence, achieved through deliberate creativity, enhances meaning, insight, and interpretation. For example, when visualizing sales data, an analyst might highlight the impact of COVID-19 to create a narrative that coheres with the larger context. By using beauty as a meta criterion, the interpreter can create holistic information that aligns with their understanding and enhances their comprehension.

Most of the best practices for visualization provided by Tableau align with our emphasis on art and beauty in representing data. Tableau's emphasis on clear purpose, audience engagement, contextual storytelling, appropriate chart choices, logical layout, effective use of color, interactivity, and accessibility reflects principles that enhance the beauty and coherence of visualizations. These practices resonate with the difference theory of information, which models how individuals create information from visualizations.

However, while Tableau's best practices contribute to effective visualizations, they are not sufficient on their own. The deeper insight and intuitive understanding that come from beautiful and intentional visualizations require more than rigid adherence to best practices. They necessitate a subjective, artistic, and intentional approach to data representation and information conception.

Nevertheless, employing a framework based on *Vorstellung* and subjective information carries inherent risks. Individuals may conceive information based on spurious differences—such as relying on inaccurate data, overlooking unnoticed filters, or encountering other perception problems. Additionally, misattributions can occur, where, for example, a dip in

sales might be incorrectly blamed on poor leadership, only to later realize that exchange rates played a significant role. Other risks include an excessive desire to generalize or create overarching patterns where none reasonably exist, leading individuals to see what they want to see or accept flawed data because it is professionally presented. These risks underscore the need for a balanced approach that recognizes both the beautiful potential and the seductive pitfalls of aesthetic data representation and information conception.

4.1. Theoretical Contribution

The fusion of the subjective theory of information with Schopenhauer's ideas of *Vorstellung* and aesthetics provides a comprehensive framework for understanding the informing process as both integrative and artistic. The subjective theory emphasizes that information is dynamically created through the perception of differences within a system, highlighting the importance of criteria in shaping meaningful information. Schopenhauer's notion of *Vorstellung* aligns with this by emphasizing the subjective nature of perception and the active engagement of the observer in interpreting phenomena. By integrating these perspectives, we recognize that informing is not merely a mechanical process but an artistic one, where the ambiguity of data can be transformed into beautiful and meaningful visualizations, beautiful in different ways to both composer and interpreter. This artistic process enhances our understanding and appreciation of information, suggesting that deliberate creativity and aesthetics can improve the informing process, making it both more effective and enriching.

This central proposition is not itself surprising or unconventional, and some might consider it self-evident. Our contribution is a novel prescription for how ambiguity can be represented beautifully via the synthesis of Schopenhauer's *Vorstellung* and subjective information. The implications of this prescription are only briefly sketched, but clearly, this fusion impacts an individual's outlook. Recognizing that subjective information is participative and involves active interpretation, the individual's outlook naturally becomes more curious, more attentive to differences, more willing to seek beauty, and more responsible. Moreover, recognizing that others create their own *Vorstellung* may enhance collaboration and foster trust. *Vorstellung* does not occur within AI systems, and our framework helps anticipate future research on differences in human and AI collaboration.

4.2. Practical Implications

For composers of visualizations, it is important to anticipate the criteria of performers and provide enough data for a comprehensive understanding, for an opportunity for beauty. Recognize that ambiguity is inherent for both you and your interpreters, that different interpreters will create a different *Vorstellung*, and be deliberate in your choices to create meaningful visualizations. Compose visualizations that help your interpreters solve their problems, that allow your interpreters to place the text of your visualization into their larger contexts. Allow them to connect not just your text but other texts to their context, so they can adapt to their environment. You and the interpreters face an unrelenting environment of uncertainty, the respite of a visualization that enables the interpreter to make sense and create even brief beauty in such a difficult environment is a worthy task.

For interpreters, it is essential to honor the composer's intent by using meta criteria such as wholeness and harmony to reconcile criteria differences and help others construct their understanding. Acknowledge the anxiety of choice for yourself and others and be deliberate in your interpretation, recognizing the subjective nature of the process. Look for opportunity to create beautiful wholes, to put the pieces of the visualization into larger contexts, allow the opportunity for the visualization to improve your view of bigger pictures. Data analysis is often described as a drill-down process, a cutting away activity; beauty is creating more complete forms, more complete wholes. And again, collaborate with other interpreters, allow others to influence how this visualization plays out in your *Vorstellung*.

More generally, when representing data, be a conductor who intentionally orchestrates the performance of data objects in the theatre of your and your audience's minds.

5. Conclusion

We began with the works of Newton, Minard, and Beethoven, highlighting a common thread despite differences in their raw materials and data. We close with two other distinct examples of participative art that place the spectator center stage, allowing them to co-create the art rather than just passively perceive it. In Munich, a major road once passed a Nazi memorial to the 1923 Beer Hall riot, where all who walked by had to give the proper salute. Resisters who turned onto a nearby side street to avoid the guards were sometimes arrested if they lacked a valid reason for being there. This side street, the *Drückebergergasse*, is paved with cobblestones. An artist replaced some cobblestones with

brass stones that turn gold when walked upon and fade to grey when not in use. This intentional design invites passersby to participate, creating a unique and personal experience as they walk the path.

In Salzburg, a statue of Mary graces a square in front of the cathedral. High up on the cathedral front, a gold crown is held by two angels. As visitors walk toward the statue with the cathedral in the background, Mary's head "rises" until it is crowned by the angels. This design places the spectator at the heart of the experience, enabling them to actively engage and co-create the visual beauty.

These examples demonstrate how participative art transforms spectators into co-creators, providing them with an opportunity to inform beautifully.

In conclusion, our proposition – that *the inherent ambiguity and complexity of our environment can be reconciled by informing aesthetically through intentional creativity* – is supported by both the subjective theory of information and Schopenhauer's aesthetics. By fusing these perspectives, we advance understanding of the informing process as both artistic and meaningful. This approach can improve the effectiveness of visualizations while also enriching the human experience by fostering deeper emotions and insights through beauty and intentionality.

While we underscore the artistic nature of information using the modern practice of visualization as an illustrative example, we leave it to the reader to interpret this insight in their own context, creating beautiful information in the theaters of their own mind as they go about adapting to their ever-uncertain and irreducibly ambiguous environment.

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