Data Montage:
Towards Coherence in Multimodal Data Representation

Sara Akhlaq, Arran Ridley, Mark-Jan Bludau, Marian Dörk
UCLAB, University of Applied Sciences Potsdam, Germany

This research explores data representations that incorporate different modalities such as vision, sound, taste, smell, and haptics, and attempts to establish their characteristics by viewing them through cinematic and theatrical lenses. Newly emerging data representations now frequently harness the combined power of visuals with other modalities and activate other sensory pathways to amplify cognition. However, these multimodal interfaces are not the only form of human interaction that mobilise different sensory pathways for communication. For instance, in the field of cinema and theatre, the Soviet-era concept of montage offered a way of combining different visuals and sounds in order to evoke associations and comparisons in a film (Li, 2014). In light of ongoing attempts to make data more comprehensible, multimodal data representations share a common goal with theatrical performances, to cater for multiple human senses and communicate more effectively. Enhancing human cognitive and perceptual abilities to understand data has been a central goal of visualization research (Card, 1999). However, combining multiple modalities creates challenges in relating these distinct units to each other and fusing them to form effective multimodal representations. We contribute to cultural heritage and collection visualization research by translating the film theory of montage to multimodal data representations to assess if it can offer viable guidance for the design and study of the latter, and by investigating how the careful combination of modal variables can contribute to the coherence and emotional impact of multimodal interfaces.

This research draws inspiration from Sergei Eisenstein's montage of attraction. According to montage of attraction, an effective theatrical performance comprises heterogeneous components that, while maintaining their meaningful individuality, when fused offer a deeply engaging and emotionally stimulating experience (Eisenstein, 2010). We propose 'data montage' as a translation of montage of attraction to multimodal data representation. Data montage signifies the careful interweaving of perceptual variables in multimodal interfaces. This research extracts the characteristics that render a theatrical experience effective and applies them to multimodal interfaces to aid the creation and critique of multimodal data representations, i.e., careful combinations of visualizations, sonifications (Kaper, 1999; Chundury, 2021), edibilizations (Wang, 2016), olfactations (Patnaik, 2018), and physicalizations (Wang, 2019). Data montage aims to present a theoretical conceptualisation, based on which multimodal data representation interfaces can be characterised, in order to be rendered more accessible, coherent, and emotionally provocative. The primary characteristics of multimodal data representation derived from montage of attraction and explored as data montage are: i) Considering the audience with diverse abilities and expertise as the main focus, ii) elevated emotional impact from the interweaving of modalities, the subject matter, and the underlying data, and iii) coherence among all modalities and the respective modal variables.

	Visualization	Sonification	Auralization	Olfactation	Edibalization	Physicalization
Tied in Knots	■		■			
COVID Death Toll	■	■				
Eyes	■	■				■
Data Cuisine	■				■	■
Commute	■	■				
Histography	■	■				
50 Years Swiss Music Charts	■	■	■			
Silent Cries of China's Depressed Netizens	■	■				
Der Sound zum Tiefen Fall der SPD	■	■				
Way of Curating	■		■			
Reconstructing Seven Days of Protests	■		■			
Museum of the World	■	■				
Smellmap of Paris	■			■		

Fig.1: Modal Table - Selected examples of multimodal data representations (examples discussed in detail are in bold)

Based on the characteristics of multimodal data representations as transcribed from montage of attraction, we apply these characteristics to examples of already existing multimodal interfaces in order to assess if data montage could be a viable lens on multimodal interfaces and as a demonstration of critical engagement with them. The selected interfaces summed up in the modal table (see Figure 1) are composed of a variety of modalities ranging from data sonification and auralization to physicalization and edibalization and encompass a wide range of cultural and humanities-related data. Subsequently, we selected four multimodal data representations: Tied in Knots (Elli, 2020), COVID Death Toll (BBC Visual and Data Journalism team, 2020), Eyes: Iris Sonification (Han, 2019), and Data Cuisine (Stefaner, 2016). We examine these projects to demonstrate our approach on a diverse set of multimodal data representations. Each of these interfaces is assessed with regard to its i) audience focus: the extent to which it caters to various tasks for users who fall on the entire expertise and abilities spectrum, ii) emotional impact: the level of emotional engagement these interfaces offer to the audiences, and iii) multimodal coherence: the coherent combination of modalities and modal variables. We introduce modality charts as a visual structure for both interpretive and generative engagement with multimodal data representations. We created modality charts for each example, to analyse the multisensory pathways, coherent use of modalities, and their combined mapping to data dimensions through the use of modal variables (see Figure 2).
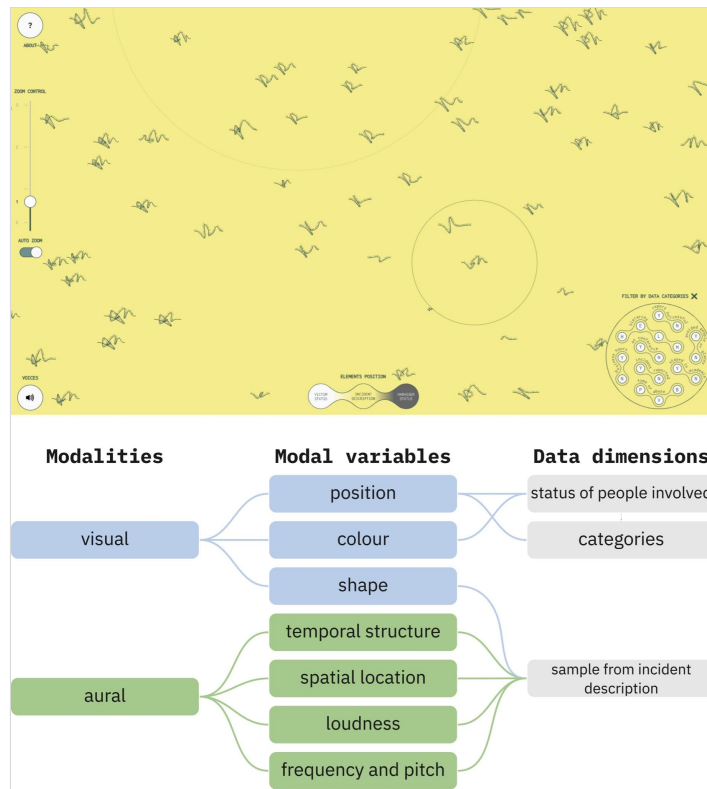
Fig.2: A Modality Chart for the Tied in Knots project (Elli, 2020).

Data montage proved to be a useful lens to examine multimodal interfaces, with regard to the different modalities they employ and the coherence that ensues when interweaving modal variables. Using modality charts to study multimodal data representations, we observed that data dimensions that are encoded to more than one modal variable from diverse modalities are more comprehensible, have magnified emotional impact, and tend to be more coherent. We also observed that there is a lack of clear distinction, where one modality ends and the other begins. These blurred boundaries favour multimodal data representations, as they are rendered more coherent and cognisable because of the overlaps of these sensory modalities. By carefully coordinating the multisensory aesthetics of a multimodal interface the multimodal encoding of data dimensions can enhance the impact, without overloading the sensory system. However, rather than diminishing or cancelling each other out, the use of modal variables needs to be carefully crafted so that they consistently contribute individually and to the entire experience. There is a need for a kind of synaesthetic sensibility in the effective design of multiple modal encodings.

We not only envision data montage as a starting point for the critical engagement with and evaluation of existing multimodal data representations but also as an inspirational framework to conceive novel data representations that use multiple, potentially still less explored modality combinations. So far this research is mainly based on theoretical grounding and our application on existing examples of data representations. Further experiments and evaluations of new multimodal data representations are still pending. We consider our work as an encouragement for the DH community to draw upon other forms of media communication and entertainment as a source of inspiration for developing multimodal interfaces. The genre of theatre with active participants and the booming field of game

design can also prove a viable source of influence and inspiration based on which we can instil data interfaces with manifold sensory activations.

References

BBC Visual and Data Journalism team. (2020). Coronavirus: How can we imagine the scale of Covid's death toll? https://www.bbc.co.uk/news/resources/idt-7464500a-6368-4029-aa41-ab94e0ee09fb.

Card, S.K., Mackinlay, J.D., & Shneiderman, B. (1999). Readings in information visualization - using vision to think.

Chundury, P., Patnaik, B., Reyazuddin, Y., Tang, C., Lazar, J., & Elmqvist, N. (2021). Towards Understanding Sensory Substitution for Accessible Visualization: An Interview Study. IEEE Transactions on Visualization and Computer Graphics, 28(1), 1084-1094.

Eisenstein, S., Glenny, M., Taylor, R. (2010). Writings, 1922-1934: Sergei Eisenstein Selected Works, Volume 1. Iran: Bloomsbury Academic.

Elli, T., Bradley, A., Collins, C., Hinrichs, U., Hills, Z., & Kelsky, K. (2020, October). Tied in Knots: A Case Study on Anthropographic Data Visualization About Sexual Harassment in the Academy. In 2020 IEEE VIS Arts Program (VISAP) (pp. 29-44). IEEE.

Han, Y. C., & Surve, P. (2019). Eyes: Iris Sonification and Interactive Biometric Art. Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, 1–4.

Kaper, H. G., Wiebel, E., & Tipei, S. (1999). Data sonification and sound visualization. Computing in science & engineering, 1(4), 48-58.

Li, X. (2014). Research on the Montage Technique in The Film and Television.

Stefaner, M., & Jaschko, S. (2016). Egguality. http://data-cuisine.net/data-dishes/egguality.

Patnaik, B., Batch, A., & Elmqvist, N. (2018). Information olfactation: Harnessing scent to convey data. IEEE transactions on visualization and computer graphics, 25(1), 726-736.

Wang, Y., Ma, X., Luo, Q., & Qu, H. (2016, May). Data edibilization: Representing data with food. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (pp. 409-422).

Wang, Y., Segal, A., Klatzky, R., Keefe, D. F., Isenberg, P., Hurtienne, J., & Barrass, S. (2019). An emotional response to the value of visualization. IEEE computer graphics and applications, 39(5), 8-17.