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# Data visualization: A unique storyteller

## ABSTRACT

*Science and technology have changed all aspects of our lives, including the mode of narration, from traditional stories to data stories. Storytellers have been integrating visualizations into their narratives. From the case studies of some artworks and our students' works to visualization research, we have found distinct genres of narrative visualization and the education method for university students. We describe the differences between these artworks, together with interactivity and information transmission. Some small experiments and some examples of students' works will be shown to explore the visual narrative. We suggest new design strategies including how to make invisible things visible.*

## KEYWORDS

narrative  
 data visualization  
 storytelling  
 design methods  
 visual narrative  
 case study  
 education method  
 interactive art

## INTRODUCTION

Storytelling is a simple and sophisticated form of art. Stories could inspire the audience, and show them ideas that are difficult to comprehend or explain. Converting data into visual content is a form of storytelling. Usually, the importance of telling a good story during data processing is overlooked, and people are not aware that data themselves are not effective if the story behind them is not properly presented.

Narrative methods, visualized contents and techniques applied for presenting have changed gradually with time. Recently, many artists have incorporated more creativity and uniqueness into their narrative methods.

1. Traditional narrative refers to the way of recording with words, videos, recordings, etc.

The development of hardware, software technologies and richer internet integration has made it possible to include more dynamic graphics and interactive experiences in artists' works; therefore more versatile and interdisciplinary narrative forms are developed.

The Economist explores the proliferation of digital data and notes that visualization designers are 'melding the skills of computer science, statistics, artistic design and storytelling'.

This article expounds the changes of narrative methods and contents in data visualization with the development of science and technology in the era of big data. Ways of utilizing this knowledge should be taught to students in order to help them become successful storytellers in data presentation.

## **THE CHANGE IN NARRATIVE METHODS AND CONTENT IN DATA VISUALIZATION**

Against the backdrop of the increasing popularity of visual forms and the increasing number of data stories, there is no doubt that the storyteller sometimes encounters some obstacles in narrative. As all cultures have their unique reading habits, it will greatly affect one's understanding of data visualization, for example, in a certain cultural environment, people are used to reading from left to right, from top to bottom, So they also follow the invariable principles when it comes to visual content. Moreover, there are other conventions: the trend to the right usually also points to the future, while the upward illustrates the trend of growth, and so on. Although these statements and rules sound commonplace, there are still some possible errors hidden in this detail, which may be caused by intentional manipulation or unconsciousness. The process of narration especially in data visualization has to undoubtedly take these details into account; a good storyteller should draw enough attention to the content of the data itself as to keep the misunderstanding caused by different reading habits to a minimum, which introduces a strong connection between the artwork and the story. The connection will provide the audience with a stronger sense of participation, which also reduces the possibility of other errors.

It is undeniable that there are also questioning voices, which are very convinced that the traditional narrative<sup>1</sup> can retain the integrity of the story. At the same time, data visualization can only express the characteristics of data, but cannot show more content behind it, which is not a good way to describe. The process of data visualization is not a one-to-one translation transformation process to display abstracted digital information; this narrative method is part of the analysis process, in which specific objectives are visualized. The presentation of the data is closely related to the content of the story to be told with the data. The form presentation of data is closely related to the content of the story. Moreover, if the story is presented in all aspects, the audience will not find the key point and may easily get lost in the details of the story, which will run counter to our original intention.

Analytics Vidhya content team has mentioned one of the best examples of data that need to be visualized: the data is about the Quartet of Anscombe, which is a set of four data sets. The results of these statistics are very similar and people cannot gain understanding from the chart, but when they are visualized, the results are completely different.

Figure 1 shows the four data sets used in Anscombe's Quartet. If you simply look at the numbers in the chart, you will find that they are roughly the same. But how would these statistics look after being visualized?

Anscombe's quartet								
I		II		III		IV		
x	y	x	y	x	y	x	y	
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58	
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76	
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71	
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84	
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47	
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04	
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25	
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50	
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56	
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91	
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89	

Figure 1: Quartet of Anscombe. Copyright Analytics Vidhya Content Team.

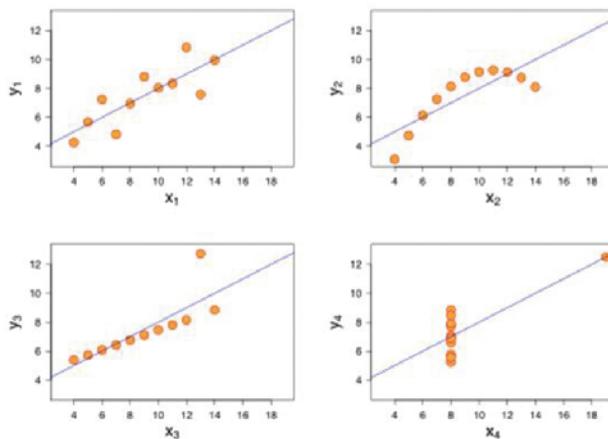


Figure 2: After data visualization. Copyright by the Analytics Vidhya content team.

Did you ever think that the gap between these four groups of data visualization would be so big? This example shows that the mode of narrative is changing and that innovation in narrative methods is making every story vivid and clear (see Figure 2).

A few years ago, when I first came into contact with data visualization, I did an experiment with my partners that made me think about how to use data or how to use new ways of visualization to convey the stories behind data. In the first project, named 'Personal Data: Daily Routines', data were obtained from records of all our activities as accurately as possible in terms of the type

of activity, duration and location. We will analyse the data and represent it as a 3D installation somewhere using cheap, lo-fi materials. The aim of this first stage of the project is to experience collection, organization and representation of data in a hands-on way. The visualizations should communicate data clearly, accurately and efficiently to enable the viewer to quickly gain an understanding of the story.

Based on the above goals, how can a set of boring data become an interesting story presentation? First of all, you need to show the real data recorded and categorize the things recorded in your daily life, and then represent different categories in different colours, such as cyan for sleep time. Pink represents learning (the learning content recorded in this part is different, and so it will be marked on display), orange represents meal time, blue stands for exercise time, yellow is shopping time, green is entertainment time and dark blue is bath time, then you need to calculate the proportion of each part in comparison to the sum total.

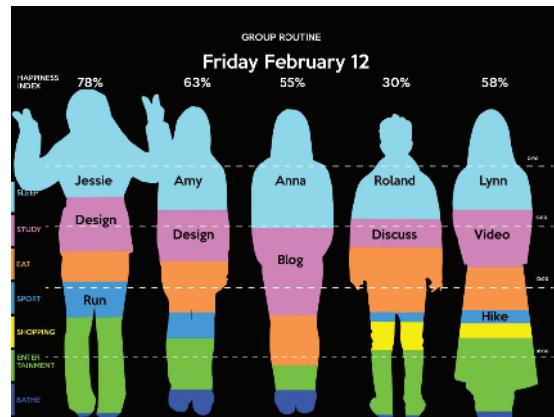


Figure 3a: Data on Friday, 12 February Visual Projection, created by Xiaoxu Dong and Roland Yu.

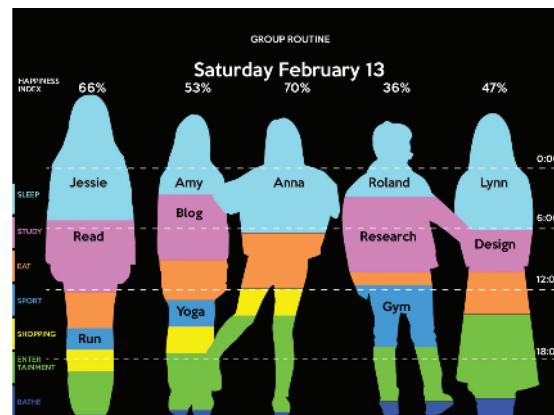


Figure 3b: Data on Saturday, 13 February Visual Projection, created by Xiaoxu Dong and Roland Yu.

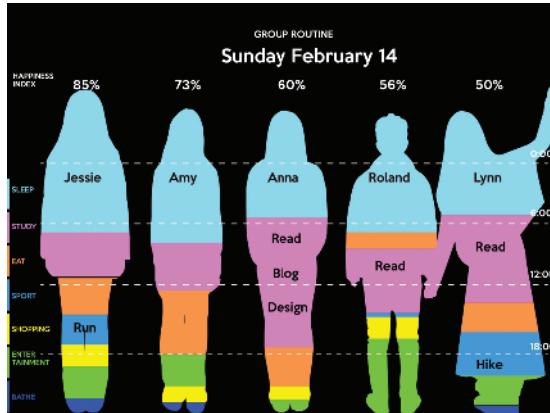


Figure 3c: Data on Sunday, 14 February Visual Projection, created by Xiaoxu Dong and Roland Yu.

Then, we utilize behavioural performance to interact with this set of data to make behaviour performance part of data visualization. Everyone performs their own data, and their data will be projected on themselves (so each person's character silhouette is used in the data presentation). In the process of display, the behaviour and dialogue of the characters can fully show the emotions behind the characters. Eventually, the story was told with a combination of data visualization and behavioural performance. We made this experiment into a video and uploaded it to YouTube. Although the experiment is very simple, we want to receive more feedback from other people who are equally concerned about the visual narrative of data. Fortunately, it has attracted many interested people. Some people who have viewed the videos have left positive messages, saying that the work has inspired them and that it is an interesting idea.

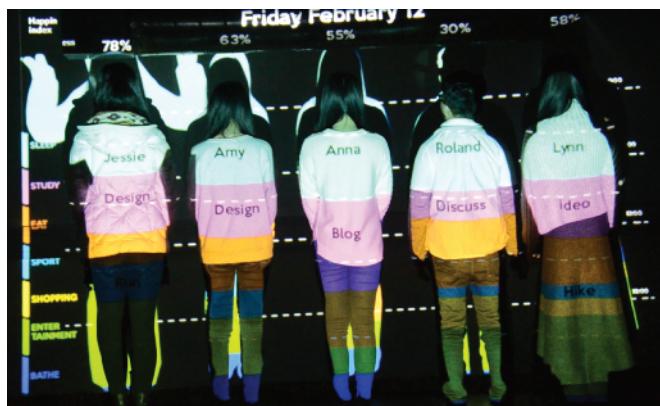


Figure 4a: Data on Friday, 12 February in performance by Roland Yu, Xiaoxu Dong, Lynn and Anna. Data in performance. Photographed by Roland Yu.

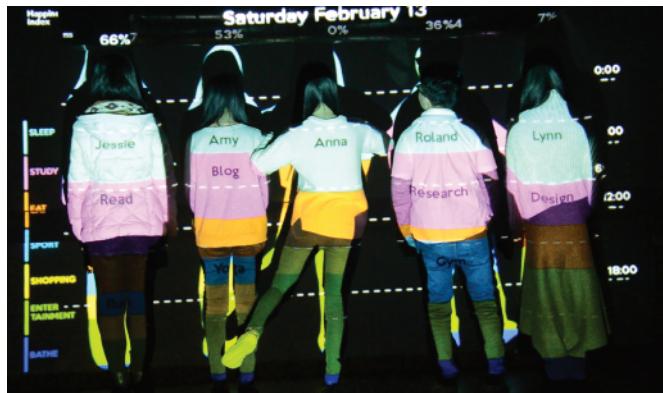


Figure 4b: Data on Saturday, 13 February in performance by Roland Yu, Xiaoxu Dong, Lynn and Anna. Data in performance. Photographed by Roland Yu.

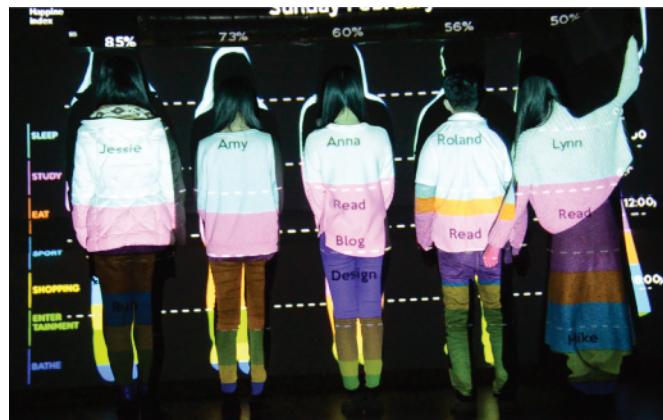


Figure 4c: Data on Sunday, 14 February in performance by Roland Yu, Xiaoxu Dong, Lynn and Anna. Data in performance. Photographed by Roland Yu.

As for the use of behavioural performances to produce data visualization, artist Keith Lam from Hong Kong, China, has to be mentioned. The work is called *Signal Morphor: The Orchestra* (Lam 2011), which is a data visualization behaviour performance, showing a work about signal and communication visualization. In the performance, the audience is also a performer, and the reception and transmission of communication signals are transformed into lights, music and images, which produce invisible signals. The dancers are the recipients and senders of the data; they will have reactions to the signal immediately after receiving the signal. Dancers have sensitive antennae that respond to signals as soon as they receive them. Each dancer has an umbrella installed with sensors to receive signals from the audience and send signals back, which establishes live communication between dancers and the spectators. A dancer can actively make phone calls, surf the Internet or send text messages; at that time they can also passively receive calls and text messages from the audience. The received signals will be converted into music and images to be projected on the screen behind the dancer (see Figures 5a–d).



Figure 5a: Signal Morphor: The Orchestra. *The performer is in the performance with data collection from the screen.* Copyright Keith Lam.



Figure 5b: Signal Morphor: The Orchestra. *The performer is in the performance with data from their umbrella.* Copyright Keith Lam.

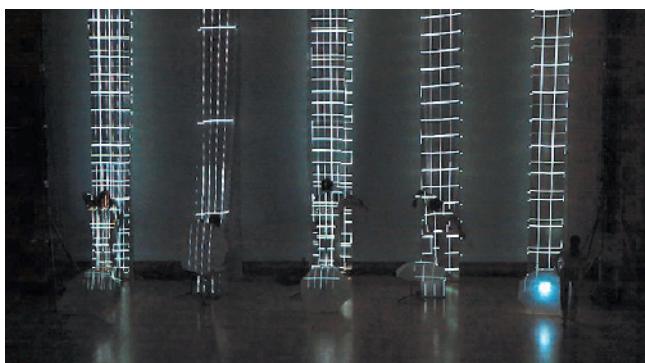


Figure 5c: Signal Morphor: The Orchestra. *The performer is in the performance with data collation from the screen.* Copyright Keith Lam.



*Figure 5d: Signal Morphor: The Orchestra. The performer, with data from their umbrella. Copyright Keith Lamb.*

The combination of performance and data visualization is a very interesting narrative method in which one aspect of data visualization can clearly show the data; on the other hand, behavioural performance can not only supplement the data but also excavate more content behind the story. Therefore, such a combination compensates for the fact that data visualization may miss the story and also greatly enriches the form of expression of the works; it leads to more artistic appreciation and interaction.

In fact, increasingly more new technologies can be developed into new artistic narrative methods that can be applied to data visualization as well. The original text form has also changed into the visual form, the sound form, the dynamic form, the sculpture form and even the behaviour performance.

In fact, increasingly more new technologies can be developed into new artistic narrative methods that can be applied to data visualization as well. From 2D data visualization to 3D data visualization, there are increasingly more ways to display data in real time and interact with audiences.

In the development of data visualization, in addition to the changes of technology, illustration and narrative methods, the content of the story is also changing. Since the discovery of the earliest data visualization around 5500 BC, built by arranging stones or pebbles, and later, clay tokens, it is used to record data, trade and sell (Schmandt-Besserat 1999a). In 500 BC, the earliest participatory visualizations were probably voting systems. Voting in Greece was introduced in the fifth century BC. Adult male citizens were invited to express their opinion by dropping a pebble in an urn: a white pebble meant 'yes' and a black pebble meant 'no'. It is clear that the emergence of data visualization in that era aimed to quantify some items and simplify the difficulty of statistics. With the development of science and technology, data visualization has been widely used in the field of

scientific research, for example Nobel laureate crystallographer Dorothy Crawford Hodgkin created a physical image in the mid-1940s that showed the structure of penicillin. Nowadays, in the era of big data, people have more convenient access to more kinds of data. Instead of confining themselves to the type of data, they choose what they are interested in in the database. Therefore, the content of visual stories in data visualization has become increasingly more abundant. In 2003, Artist Marilyn Taylor created an artwork called *Time Pieces: Physical Space-Time Cubes* that consists of seven three-dimensional maps (one for each day of the week), where the Z-axis represents time and copper wires show how she travels through the city during the day. On the Birmingham Made Me Design Expo, Dorota Grabkowska and Kuba Kolec created an interactive public installation. This project is based on the concept of data visualization, and produces large-scale and complex data maps by viewers themselves. The aim of the project is to explore the shape of the Birmingham people by asking the Birmingham people the following five simple questions:

1. What made you think?
2. What made you create?
3. What made you angry?
4. What made you happy?
5. What made you change?

Visitors can visualize concepts associated with feelings, inspirations, ideas and influences by selecting colour lines that correspond to feelings, inspirations, ideas or influences and linking these lines to words on the wall. The project has won the Most Original Exhibit Award at the Birmingham Made Me Design Awards 2012 (see Figures 6, 7a–b, 8, 9 and 10a–e).

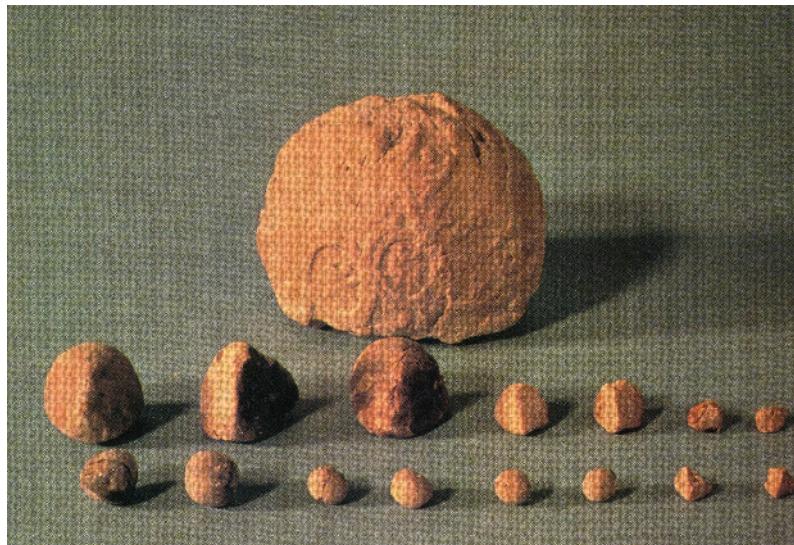


Figure 6: Earliest data visualization. Photographed by Denise Schmandt-Besserat.  
Copyright by Denise Schmandt-Besserat.



Figure 7a: Voting with psephoi (pebbles) in a scene from the Wine Cup With the Suicide of Ajax (detail), about 490BC, attributed to the Brygos Painter. Red-figured kylix made in Athens. Terracotta, 4 7/16 in. high x 12 3/8 in. diam. The J. Paul Getty Museum, 86.AE.286.



Figure 7b: The ancient Greeks held one of the earliest public votes in history when the Persians threatened their democratic system. Copyright by YouTube channel HISTORY.

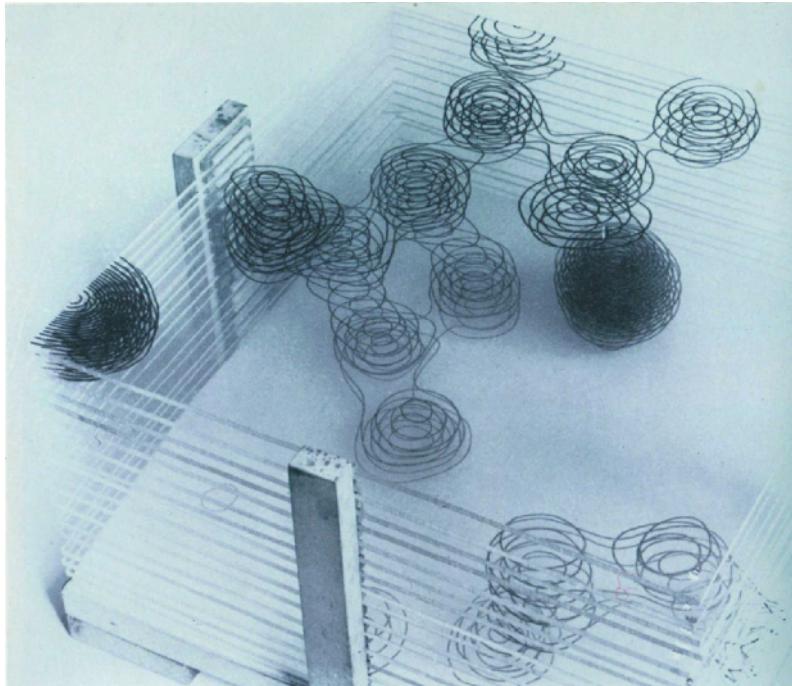
## CASE STUDIES OF NARRATIVE VISUALIZATION

### AQhelminthes

This is an assignment for the cyberception course. When the student is thinking about this project, his or her first inspiration is to find something closely related to society, people and the environment to do experiments, so as to change his or her perception of something.

The topic eventually chosen was AQI, which according to the students reflected the rising general awareness of environmental issues today.. Although low air quality has been detrimental to our health, it took us a long time to realize that. The belated attention to this issue created an especially urgent need to address problems related to air quality.

Instead of enlisting AQI data as a set of numbers and figures that do not emotionally engage the audience, my students' work was able to paint a vivid picture of the threat that bad air quality had posed on us through data visualization. They created a virtual creature. The air quality is reflected by the virtual creature's living condition. Its life span is programmed to be much shorter than that of humans and it is more sensitive to air pollution conditions; thus



*Figure 8: Structure of penicillin. Copyright: Dorothy Crowfoot Hodgkin.*



*Figure 9: Time Pieces: Physical Space-Time Cubes. Created by Marilynn Taylor.*

the audience receives feedback through the creature's status and emotion connections can be established between it and humans (see Figure 11).

Throughout his narrative process, the source of the data is the National Meteorological Administration's API. He converts all the data into the virtual creature's living condition (health condition). The virtual creature's form is inspired by the dynamic form in Artist Golan Levin's Yellowtail (see Figure 12). Yellowtail (Levin 1998) is an interactive software system for the



Figure 10a: *WHAT MADE ME* interactive public installation.  
Designed by Dorota Grabkowska and Kuba Kolec for  
the Birmingham Made Me Design Expo (15–22 June 2012) at the  
Mailbox, Birmingham. Copyright Dorota Grabkowska and Kuba Kolec.



Figure 10b: *WHAT MADE ME* interactive questions  
and tools.

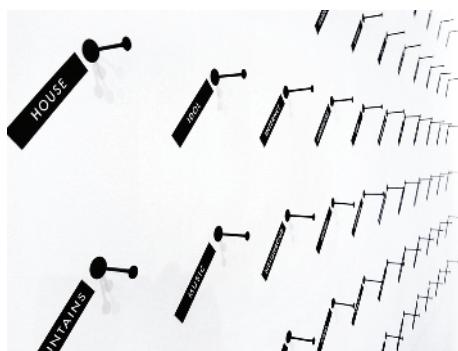


Figure 10c: *WHAT MADE ME* installation  
details.

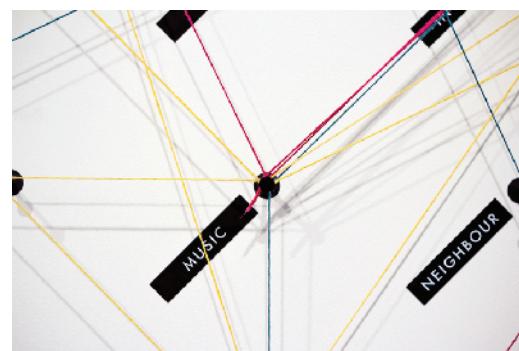


Figure 10d: *WHAT MADE ME* interactive outcomes.

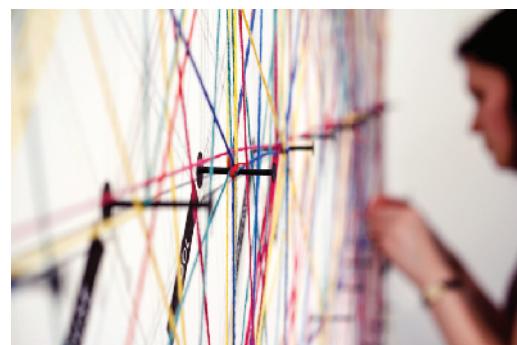


Figure 10e: The audience interacting with the installation.

gestural creation and performance of real-time abstract animation. Yellowtail repeats a user's strokes end-over-end, enabling simultaneous specification of a line's shape and quality of movement. Each line repeats according to its own period, producing an ever-changing and responsive display of lively, worm-like textures.

In this story about air quality, the data correspond to the virtual creature's movement speed, life cycle, environment colour tone and the colour of the creature itself. The background colour is the same as the colour pointed by the pointer. The colour, size and creep strength are all affected by the index. This work changes people's perception about the air pollution in time dimension. It converts a long-term problem into fifteen minutes of visual images.

This is an example of telling a meteorological story with the help of data visualization. In this project the student tells a story of the air quality through the living conditions of a virtual creature. The narrative method is relatively quite clear and integrated. The 'new life' created in this project becomes a new communication system. It has successfully presented the data, changed the perception of the audience and enhanced their experience.

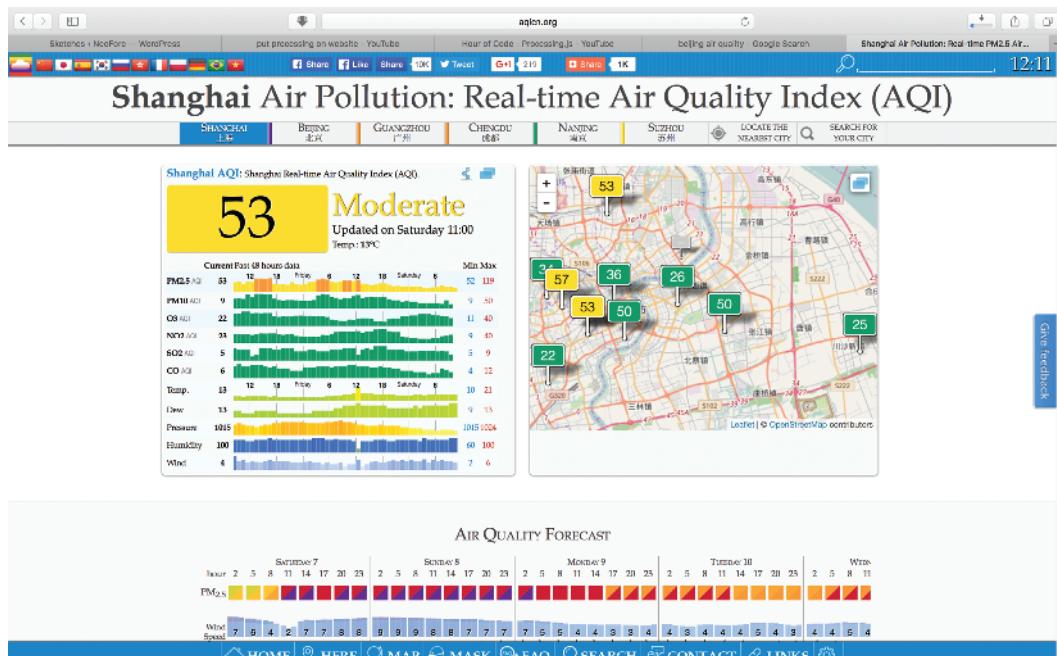
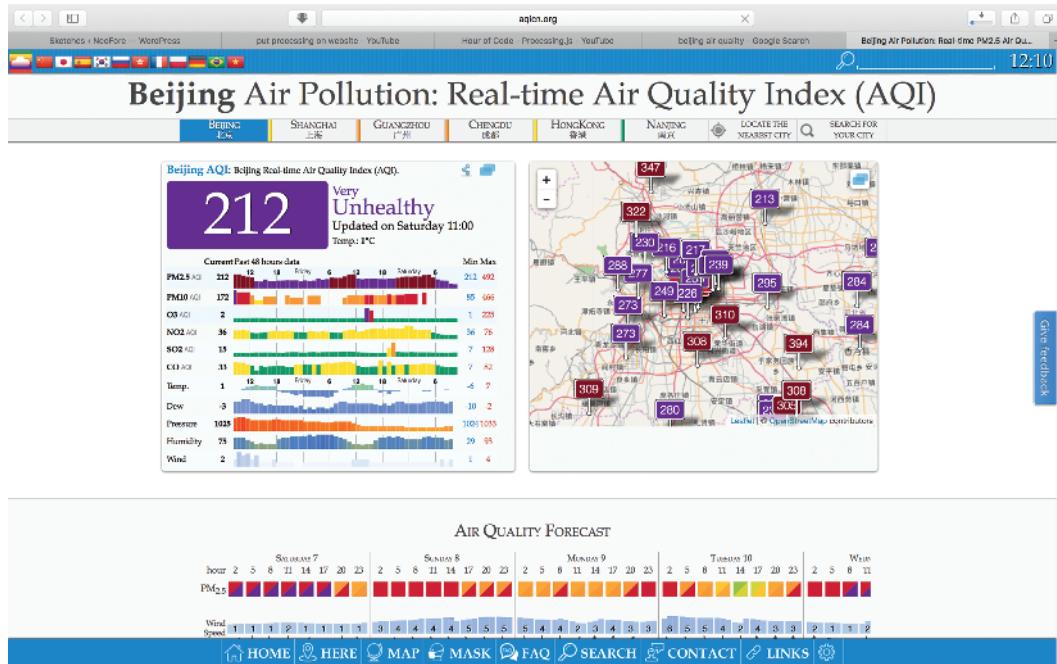
### **Channel**

*Channel* tells a story with data visualization in which a human enters a huge plant network and establishes an intimate connection with the plants (see Figures 13a–c). As we all know, the human body is an elaborate system; the huge society that humans live in is also an enormous, complex network system. Looking at an individual, we will find that there is a circulatory system composed of a large complicated network, transporting materials inside a human body. If we look at humans from a societal perspective, we will find the Internet connecting individuals with the whole society and social relationship networks that keep humans connected to each other. In fact, there is also a network among plants. The Wood-wide Web is a mycorrhizal network. Mycorrhizal networks are underground hyphal networks created by mycorrhizal fungi that connect individual plants together and transfer water, carbon, nitrogen and other nutrients and minerals.

The aim of this project is to raise a discussion about how the relationship between human beings and plants will change as our technology develops and the identities of human beings and plants in this network. Just like in the film *Avatar*, in which people could communicate with the plants through the hairs and roots, we want to show the communication of the audience with the plants.

As the name 'channel' suggests, the project contains multiple channels that the audience can choose from. When creating the project, the interaction interface was designed as a frequency modulation knob and a human heart-beat sensor was used to detect a plant's 'heartbeat' signal. We found during the experiment that the signals would change when humans touched the plants. The four plants acted as four interfaces through which we could enter the network of plants which are interconnected with each other.

The deep connection between the human and plant, real albeit invisible, was visualized and rendered tangible. The four real plants correspond to four virtual plants on the screen, and the forms of the virtual plants are artistically stylized. The connection between the two systems will be shown when the audience touches the plants. Through this project, the audience can not only enter into the plant's network and 'communicate' with the plants, but they can also explore their communication status by the visualized graphics on the screen.



Figures 11a-d: Air quality index. Copyright: The World Air Quality Index Project Team.

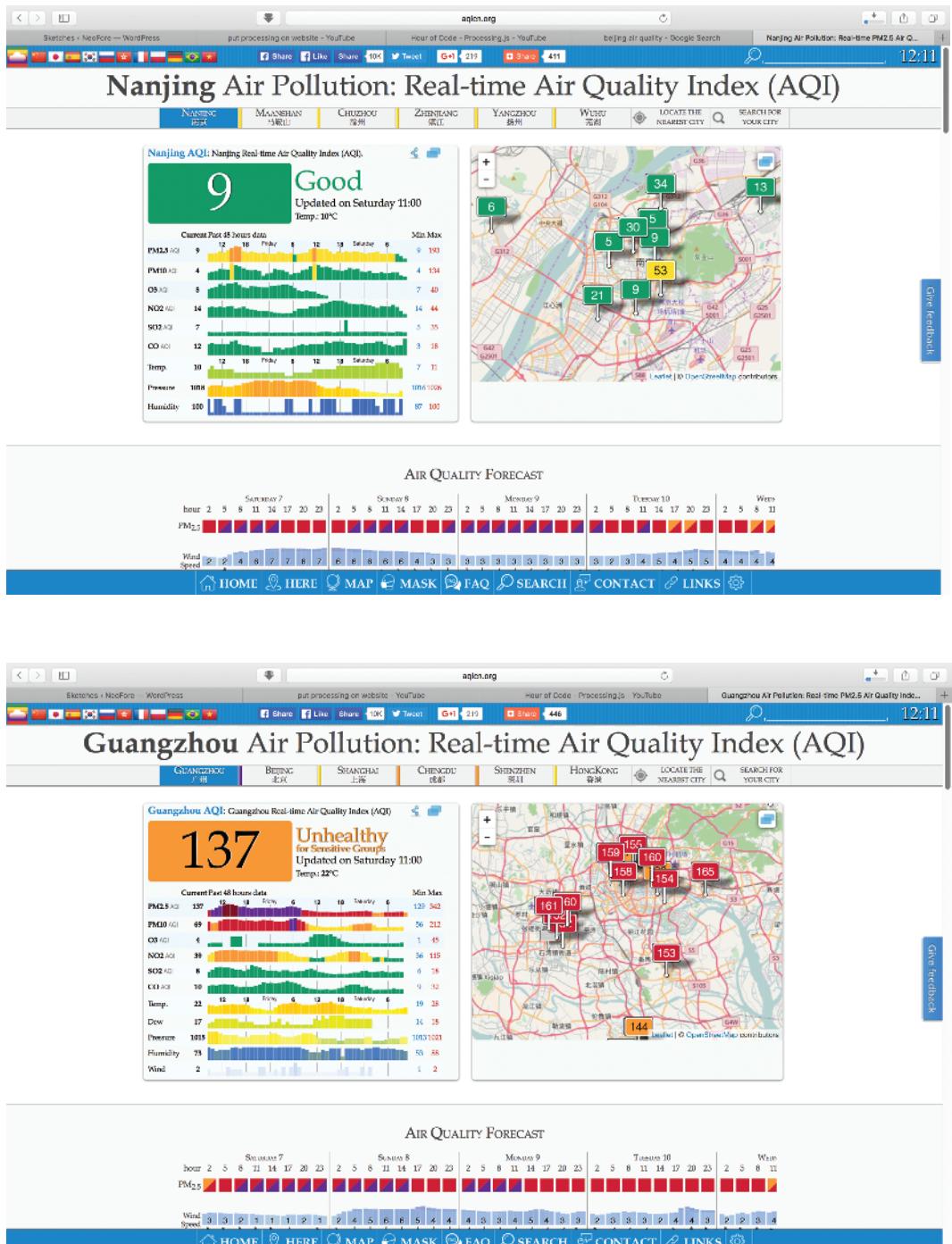




Figure 12: *Yellowtail*. Designed by Golan Levin.

### **Attention**

*Attention* is a student work that has won the second prize in a competition held by Tongji University. The work captures the brainwaves when human beings pay attention to the form of electronic signals and display them on a screen for direct visual mapping (see Figures 14a–b and 15a–b). Compared to the previous cases where data was still somewhat taken from the external world, these students managed to extract data from something as abstract and latent as human attention and consciousness.

René Descartes in his famous dualism theory mentioned that the universe contains two radically different kinds of substances – the mind or soul, defined as thinking. Humans can recognize their own physical form from their reflection in the mirrors. In this project, *Attention* visualized humans' thinking process by technological methods. A visualized mapping from electroencephalogram (EEG) provides a chance to recognize and access the 'soul' part of one self; through this 'mirror' we can see our own 'consciousness'. Conventional mirrors reflect the physical body and this 'mirror' reflects human consciousness. Then a question arises: what is the true core identity of a human being in the post-human society: is it the consciousness or the physical entity in the mirror?

In this project, EEG is used to collect human brain bioelectrical signals, the beta brainwave. According to scientific research, beta brainwaves represent humans' attention status, and it is a simple and controllable psychological activity. Then the beta wave is extracted by the sensor, processed and manipulated into visualized particle forms by utilizing certain mathematical techniques. The experiencer's attention is thus visualized as a particle system. The contraction and expansion of the particle system reflects the focus of one's attention; the audience can adjust the colour style of the particle system through the interface.

The motivation and concept of this project are both intriguing and thorough. Intangible data are collected, analysed, processed and displayed in real time, enabling a human being's attention to be quantified in the blink of an eye. The audience will ask themselves questions tinted by the story while they experience the story. What is the true core identity of a human being in the post-human society: is it the consciousness or the physical entity in the mirror?

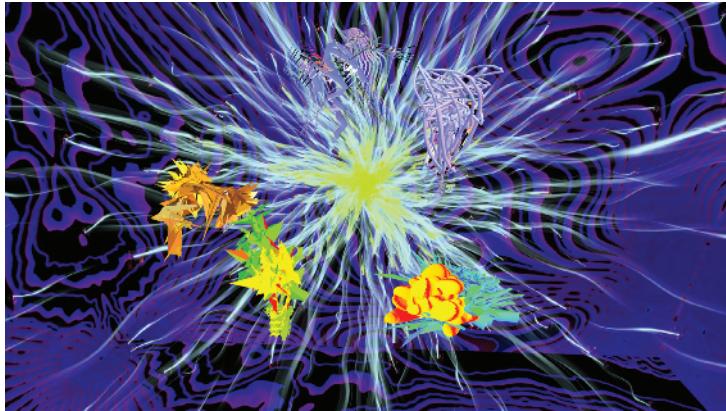


Figure 13a: Interface. Created by Bill Zhou and Odelie Liu. Copyright: Bill Zhou, Bobby Xu, Lou and Odelie Liu.

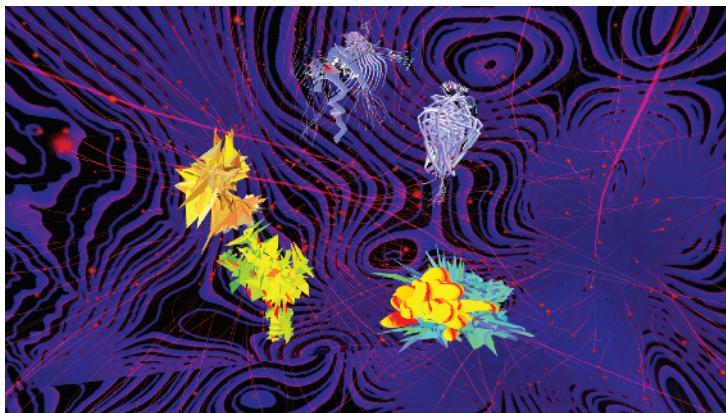


Figure 13b: When viewers touch different plants, the interface shows different communication situations. Created by Bill Zhou and Odelie Liu. Copyright: Bill Zhou, Bobby Xu, Lou and Odelie Liu.

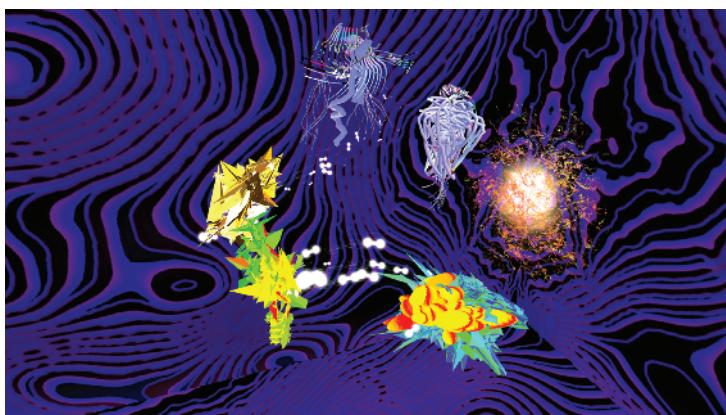


Figure 13c: When Kinect catches humans approaching.



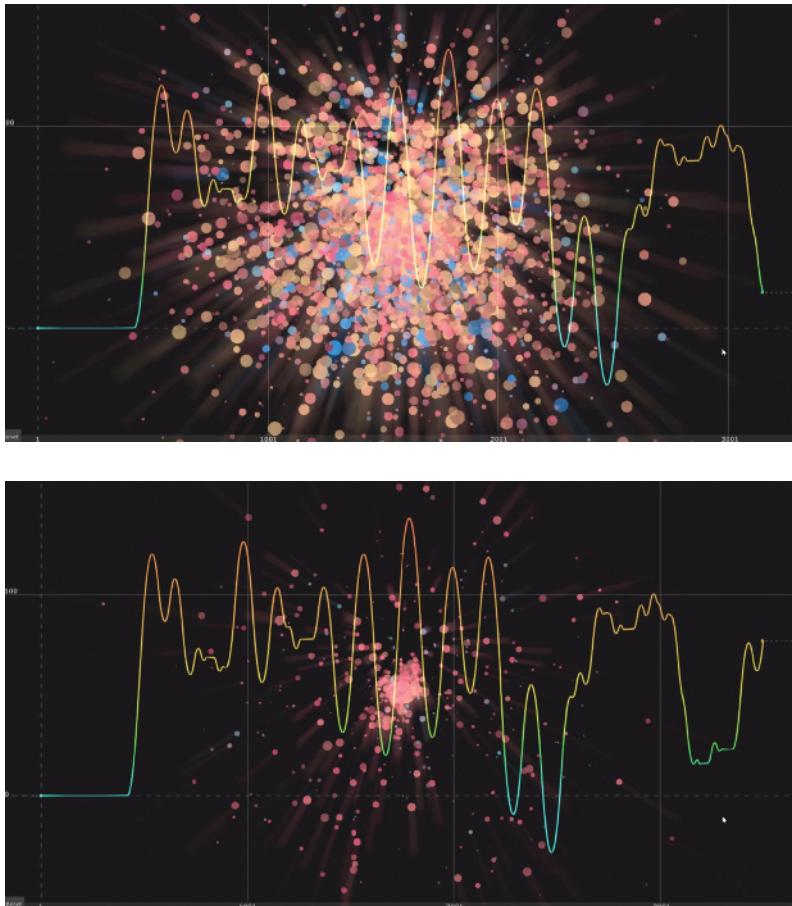
*Figures 14a–b: When the audience interacts, the interface data changes as the audience's attention changes. Designed by Hill Jiang. Copyright Hill Jiang, Tony Ding and Lou.*

## CONCLUSION

In this article, we compared a conventional narrative and a data story narrative. Compared to traditional narratives methods, data storytelling appeals to our senses and emotions in a much more powerful and engaging way. With the development of science and technology, narrative methods and presentation methods have all changed considerably.

With the assistance of these technologically enhanced storytelling methods, artists have injected vitality into data and made them vivid tales. Moreover, the growing range of data has also given artists much more freedom in choosing their subject matter. Besides texts, artists are also able to visualize tabulated data, as well as many other types of 'invisible' data.

We illustrated two examples of narratives combining data visualization and performances. Similar bold experiments have always given people many inspirations and afflatus. These narratives are not merely showing the data but are of higher artistic merit and stronger interactivity. Three more examples come from



*Figures 15a–b: The effect of particles on the interface increases with concentration.*  
Designed by Hill Jiang. Copyright Hill Jiang, Tony Ding and Lou.

undergraduate students' work from the Roy Ascott studio. As undergraduate students, they have not only used data visualization as a narrative method but have also focused on intriguing topics in their stories, ranging from meteorology, plant network, to human attention. Each project told a unique and fascinating story about data, which would otherwise be dry and un intelligible.

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## SUGGESTED CITATION

Dong, Xiaoxu (2019), 'Data visualization: A unique storyteller', *Technoetic Arts: A Journal of Speculative Research*, 17:3, pp. 259–79, doi: [https://doi.org/10.1386/tear\\_00020\\_1](https://doi.org/10.1386/tear_00020_1)

## CONTRIBUTOR DETAILS

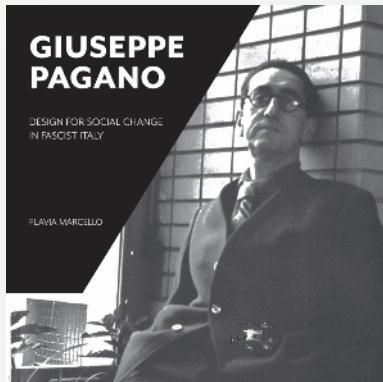
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# Giuseppe Pagano

## Design for Social Change in Fascist Italy

By Flavia Marcello

Giuseppe Pagano-Pogatschnig (1896–1945) was a twentieth-century polymath operating at the intersection between architecture, media, design and the arts. He was an exhibition and furniture designer, curator, photographer, editor, writer and architect. A dedicated fascist turned resistance fighter, he was active in Italy's most dramatic social and political era.

This book provides a comprehensive overview of an influential architect and his contribution to the development of modern architecture. It follows his life with in-depth contributions about aspects of Pagano's cultural production, concluding in writings by Pagano himself and a critical bibliography to aid scholars in further study.

ISBN 978-1-78938-100-9  
350 pp | £40, \$56  
Paperback | Fall 2019  
220 x 220 mm  
E-book available

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