Information Visualisation for Digital History
Participatory Solutions for Reviewing Best Practices

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Summary: In the era of big data, information visualisation enhances the user experience of digital history. Visualisation techniques help researchers to generate new insights from structured historical information and enable scholars and the layman to interact with historical information effectively and instantly. The results of previous research can be “read” visually and direct the exploration of relevant information. This paper examines five typologies of information visualisation techniques (Radial Tree, Force-Directed Graph, Satellite View, Treemapping, and OpenStreetMap) and reviews some best practices of their use in digital history as examples to engage participation in sharing more best practices and discuss the future of information visualisation for digital history.

Introduction

Information visualisation has become an essential and meaningful approach for digital history to read complex data into a visual representation. One can agree with the American public relations scientist Doug Newsom when he writes that visual expression is the product of human's constant challenge to communication. In the era of big data, new visualisation solutions are implemented and can be tested and successfully used by historian in their perennial chase for truth. In recent years, the influence of visual imagery has advanced and new tools and techniques have been increasingly exploited to the benefit of interdisciplinary researches. In this context, digital history is not only a guide for retrieving primary historical information, but also generates new researcher opportunities to understand, compile, and explore secondary literature. Therefore, good information visualisation can help to explore available resources and enlighten the relations among different historical information, to better promote the sharing and interpretation of historical memory at large.

In this paper, five main types of information visualisation will be presented as participatory opportunities for digital history. To start the discussion, some best practices related to the

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use of Radial Tree, Treemapping, Force-Directed Graph, OpenStreetMap and Satellite View in
digital history will be discussed. This exercise generated and information visualisation application
that enables scholars to submit website reviews using an online template. The peer-reviewed
reviews will be made available on the Engineering Historical Memory.

Radial Tree

The Radial Tree is a type of information graphic which displays a tree structure in a way that
expands outwards, radially. By using a Radial Tree approach, the visualisation of digital history,
which helped users to quickly verify the relevance between sources by replacing text with vision.
Here below eight best practices are presented to discuss their contribution to digital history.

Best Practice 1: Wayang Kontemporer

Wayang Kontemporer\(^1\) is an interactive PhD dissertation completed by Miguel Escobar in 2014 and
examined in 2015 in the Theatre Studies Programme of the National University of Singapore. It is
part of the Contemporary Wayang Archive (CWA) studies, a collection of re-elaborations of Java’s
oldest performance tradition of wayang kulit, which was found in different parts of Java and Bali (Indonesia) as well as Malaysia. This archive includes new versions of Javanese wayang kulit
intimately connected to the cultural life of Java, traditional dance, architecture, and textile art.
Users can read the different chapters by selecting them from the navigation panel in the left texts or
display diagrams by selecting the titles of the performances in the right radial tree diagrams (Figure
1). This helps the user to clearly understand the relevance and proportion between language,
puppets, music, space, and story, so that the users can understand “Javanese wayang kulit” more
easily.

The innovation of this case study lies in interactive visualisation. It is worth nothing that the research
paper of CWA focused on text description. Interactivity and visualisation make the paper more
interesting and easier to read.

![Figure 1. Wayang Kontemporer](http://cwa-web.org/en/about)

Best Practice 2: UNESCO’s Interactive Visual

UNESCO’s Interactive Visual\(^2\) is an interactive website for visualising “Intangible Cultural
Heritage (ICH) inscribed on the Urgent Safeguarding list” as approached by data-visualisation
designer and artist Nadieh Bremer for UNESCO. It was elaborated using the visual model of Radial

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1 http://cwa-web.org/en/about
2 https://ich.unesco.org/dive/domain/?language=en
Tree, displaying how the living heritage elements inscribed under the 2003 Convention relate to the UNESCO five domains.

It consists of three circles. The outer circle refers to the countries, which was divided into six categories according to the region: ‘Western European and North American States’, ‘Arab States’, ‘Asian and Pacific States’, ‘Eastern European States’, ‘Latin American and Caribbean States’, and ‘Sub-Saharan African States’. The inner circle refers to the domains in the 2003 Convention, such as ‘Traditional craftsmanship’, ‘Oral traditions and expressions’, ‘Performing arts’, ‘Social practices’, “Rituals and festive events” and “Knowledge and practices on nature and the universe”, while the middle circle was graphical ICH, connecting domains and countries respectively.

Cultural heritage helps us interact and learn from the past and contributes to our intellectual and cognitive evolution. This website can help users to better understand their own past and culture. When users move their pointer over any of the objects, they can see all its connections (Figure 2). While users click on it, they can see an information pop-up for the ICH\(^3\), such as videos, pictures, and text description (Figure 3).

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1 https://ich.unesco.org/dive/domain?language=en
Best Practice 3: All Olympic Gold Medals Winners

All Olympic Gold Medals Winners is another interactive website designed by data-visualisation designer and artist Nadieh Bremer. It exhibits the history of Olympic champions from 1896 to 2016. Since 1896 was the first year of the new Olympic Games, this year spreads visually and chronologically outward from 1896 to 2016, forming concentric circles. Each circle represents a grouping of several different themed sports, such as water sports or ball games. The visual project used a light blue and pink background to distinguish the sexes, with the former representing males and the latter representing females. Users can clearly see the total number of gold medals won by men and women in each event from 1896 to 2016 (Figure 4). Finally, users can hover their pointer over the squares to view current Olympic records.

![Figure 4. Radial Tree Visual for All Olympic Gold Medals Winners](image)

Treemapping

Treemapping is a method of displaying large hierarchical data as a set of nested rectangles. History is continuous and the historical data is connected. With the help of hierarchical management data, users can identify object types as well as the relationship between different objects easily. Three best practices are presented here below.

Best Practice 1: Ageing population in Europe

Ageing population in Europe was developed at Linköping University in Sweden. NComVA presents innovative visualisation technology that focuses on the most ancient of social rituals: ‘storytelling’ – exemplified through telling a story about the age groups for NUTS2 regions in Europe. Users can dynamically participate in this interactive process. The elderly population (i.e., people aged 65 years and over) in European countries increased almost three times faster than total population between 1995 and 2011. This European tree map visualisation shows hierarchies in which the rectangular screen space is divided into about 1000 European NUTS2 regions. Each region belongs to a country in the hierarchy. This colourful presentation accommodates thousands of statistical data items in a meaningfully organised display allowing patterns and exceptions to be spotted immediately (Figure 5). The size of the rectangle refers to ‘Total Population’ while the colour attribute represents elderly population in Europe ‘age

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4 http://www.datasketch.es/august/code/nadieh/
5 https://ncva.itn.liu.se/education-geovisual-analytics/treemap/?l=en
group 65+ in %. When the colour and size dimensions were correlated in some way with the tree structure, one can easily see patterns that would be difficult to spot in other ways.

Figure 5. Interactive Treemapping Visual for Ageing population in Europe

**Best Practice2: Afro-Eurasia Information Visualisation-Treemapping**

EHM6 used pre-modern Afro-Eurasia between 1205 and 1533 as a case study for interactive global histories. The Fra Mauro map dated 1460 and the Genoese World Map dated 1457 investigated at the same time and explored through, among others, a Treemapping visualisation. All five information visualisation techniques were experimented in the Fra Mauro and Genoese world maps, including Radial tree, Treemapping, Force-Directed Graph, OpenStreetMap and Satellite View to facilitate researchers in understanding the intercontinental geographical locations in Afro-Eurasia. The treemapping is particularly interesting because it shows the number of cities in today’s countries. It helps the user to get an understanding of the proportion of countries and cities in Afro-Eurasia (1205-1533). The boxes represent the countries, and the size of each box gives the percentage of historical items. When the user points on a country, he/she can see the group of cities showed in both Fra Mauro’s and the Genoese maps (Figure 6).

Figure 6. Afro-Eurasia Information Visualisation-Treemapping

**Best Practice3: World Life Expectancy At Birth (1800-2011)**

World life expectancy at birth (1800-2011)7 was done by Mikael Jem, NComVAAB. It combines tree map and map visualisations to dynamically show historical data on ‘life expectancy at birth’ country by country from 1800 to 2011.

6 https://engineeringhistoricalmemory.com/AfroEurasiaMap.php?vis=sat
7 https://ncva.itn.liu.se/education-geovisual-analytics/treemap?l=en
The site distinguishes people's life expectancy in a colour scale from light blue to red: the redder is the colour, the longer is the life expectancy in the area. There is a play button at the bottom of the webpage, which can dynamically display the changes of the ‘life expectancy at birth’ in different countries from 1800 to 2011. When users press pause, they can hover over the country box on the Treemapping to see the total population and ‘life expectancy at birth’ of the country in that year. Fundamentally, this site's visual display of tree map helps users to see the number of people and the ‘life expectancy at birth’ of each country clearly and at a glance: the bigger the square, the more people, and the redder the square, the longer is the average life expectancy (Figure 7).

![Interactive Treemapping Visual for World life expectancy at birth (1800-2011)](image)

**Force-Directed Graph**

Force-directed graph are a class of algorithms used to draw graphs in a meaningful way, where the nodes of the graph can be displayed in a two-dimensional or a three-dimensional space. It can dynamically display the process of the entire layout gradually converging and stabilizing, so that users can experience and understand large historical information datasets more easily and faster. Three best practices have been selected.

**Best Practice1: Singapore Biographical Database**

The Singapore Biographical Database\(^8\) is a website that allows users to search for information about Singaporean Chinese ancestors and their social networks. It was designed by Kenneth Dean for the National University of Singapore, the National Library Board of Singapore and the Singapore Federation of Chinese Clans Association.

In addition to providing the archives, this website also established a sub-website for searching the full social network of 200 prominent Singapore Chinese personalities with the force-directed graph visualisation (Figure 8). The nodes represent the focus of the Singapore Chinese personalities in this project who come from different regions, such as Hainan, Teochew, Canton, Hakka, Hainan and Sam Kiang, and are distinguished by different colours. Users can hover the mouse on the links to see the interpersonal relationships, and then click the node to view the specific person information.

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\(^8\)http://sbdb.nus.edu.sg/Network/index.html
Best Practice2: A Constellation of Living Heritage

By using web-semantics and graphic visualisation, ‘Dive into Intangible Cultural Heritage’ proposes a broader conceptual and visual navigation through close to 500 elements inscribed on UNESCO’s lists of the 2003 Convention, including ‘Constellation’, ‘Biomes and natural resources’, ‘Domains of the Convention’ and ‘Threats’.

This interactive visualisation presents a constellation of living heritage. It was designed by data-visualisation designer and artist Nadieh Bremer to show the diversity and interconnectedness of the living heritage elements inscribed under the 2003 Convention, helping people understand and discover their cultural heritage.

Navigating by concepts such as ‘Dance’, ‘Family’, or ‘Costumes’ to present almost 500 communities in over 100 countries (Figure 9), users can move the pointer over any of the objects to see all their connections, and click on any of the them to “fix” it, after which they can click a "+" icon next to it to see more information. Moreover, the Stroke circles of different sizes represent the connections, meaning the bigger has more connections.

Best Practice3: The Indo-European Language Tree

The *Indo-European Language Tree* is a force-directed network graph designed by Highcharts, a company that aims to make easy for everyone to visualize data on the web.

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10 [https://www.highcharts.com/demo/network-graph/sand-signika](https://www.highcharts.com/demo/network-graph/sand-signika)
In this force-directed graph of Indo-European Languages, each of the nodes represents a language and connects the language families they belong to. It clearly illustrates the types, sources, and connections of languages. Users can drag a node and reposition it dynamically. Although it does not provide much detailed information, it was helpful to promote the historical study of language development (Figure 10).

![Figure 10. Force-Directed Graph for Indo-European Languages](image)

OpenStreetMap provides user-generated street maps that can be free editable. It contains a wealth of geographic data and provides a lot of useful tools to users interested in geography, spatial analysis, and spatial planning. It is a collective project that provides a great help in supplementing and searching historical resources. Some best practices are discussed here below.

**Best Practice 1: Mapping the Russian Empire**

The so-called Imperiia Project\(^1\) hosted by the Davis Centre for Russian and Eurasian Studies at Harvard University is a historical geographical information system that promotes the study of Russia’s spatial history (Figure 11). Despite the rich archival and library information about the Russian Empire, there is still a big gap in the understanding of how the Empire works. For example, how do people, objects, ideas, and all kinds of living and inanimate objects move from one location to another? The Interactive Russian Empire Map restored the historical geospatial environment of the Russian empire and helped users to understand the empire in its spatial history from the perspective of the people who lived there.

This map enables a series of annotated datasets and historical maps related to the physical infrastructure, demographics, culture, and economy of the tsarist state. It assists instructors in bringing interactive engagement with maps and geographical information into the history classroom.

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\(^1\) [http://worldmap.harvard.edu/maps/886](http://worldmap.harvard.edu/maps/886)
**Best Practice 2: Digital Johnson County**

*Digital Johnson County*[^12] is a collaborative effort of the Department of History of the University of Iowa, the State Historical Society of Iowa, the Office of the State Archaeologist (OSA), the Iowa Department of Natural Resources (DNR), and the University of Iowa Libraries Office of Digital Research and Publishing.

This map provides a public tool and an open data layer that documents the social, natural, and political history of Johnson County, Iowa (Figure 12). The data bar on the left contains the historical and archaeological layers developed by OSA, geo-rectified maps and atlases from the UI Libraries collection, project-specific layers developed by students and faculty in the Department of History, and relevant layers developed and maintained by the DNR’s Natural Resources Geographic Information Systems (NRGIS) Library.

Users can add layers to supplement historical information and create public resources that they can use to assist academic research and history learning. For instance, they can interact with the best available public data for cities, regions or continents and see the whole area and zoom into a specific place. Users can also aggregate contemporary and historical data provided by researchers and make them permanently accessible online, using spatial information for interdisciplinary and organisational collaboration in an online environment.

![Digital Johnson County Map](image-link)

**Figure 12. Digital Johnson County**

**Best Practice 3: The Boston Research Map**

*The Boston Research Map*[^13] is an ongoing project of the Boston Area Research Initiative (BARI) in collaboration with the WorldMap team. It is an open source web mapping system that helps

[^12]: http://worldmap.harvard.edu/digitalJC/
[^13]: http://worldmap.harvard.edu/boston/
teachers and students, policymakers and practitioners, and community members to explore the Boston neighbourhood on the internet (Figure 13). This map contains detailed information about Boston, such as Historic Maps, Boston Neighbourhood Survey, Transportation, and more. Users can also browse the map visual effects they like, such as 'Stamen Toner', 'Stamen Watercolour', 'OpenStreetMap' and 'No Background'. Moreover, the site allows users to interact with the best public data available in the Boston area while uploading their own data. They can also view the entire Boston area, zoom into specific locations, and use spatial information online for interdisciplinary collaboration, thus accumulating contemporary and historical data from researchers and the general public and becoming a Boston research platform with permanent online access.

![Figure 13. OpenStreetMap for Boston](image)

### Satellite View

Satellite View provides image data obtained by photographing or scanning earth or other planets by various artificial earth satellites. The utilized of satellite images to study the global structure and the evolution of the earth is very effective, providing a new evidence for the theory of continental drift. Some best practices are presented here below.

#### Best Practice 1: New Haven Building Archive

*The New Haven Building Archive (NHBA)*[^14] directed by Yale University. It was a database of Yale University Students' research on local architecture and is still being updated. It aimed to stimulate people’s interest in the building environment and train themselves in how to "read" buildings as physical and social objects, and to create a living archive that invites new layers of information, imagery, and stories.

The website combines maps and satellite images. On the left are displayed optional buildings, such as ‘1040 State Street’, ‘M. Armstrong and Compar’, ‘The Construction Centre’, etc., as showed in Figure 14. When users click on a building they want to know about, the building is popped up with detailed introduction information, including construction year, purpose, social history, site history, structural data, etc.

[^14]: https://nhba.yale.edu/
Best Practice 2: Singapore Historical GIS

This Singapore Historical GIS Website\(^{15}\) is based on “A Historical Geographical Information System for Singapore” project funded by the Singapore Ministry of Education. It uses interactive online maps to demonstrate the distribution of cultural sites in Singapore across space and over time. The website results in a comprehensive historical geographic information system (Figure 15). The project is innovative in three ways: first, it integrates Chinese and English archival resources into a searchable database; second, it integrates archival resources with fieldwork data from Chinese social and cultural institutions over the past five years into a geographic information system; third, it provides a platform for users to generate their own database of distribution features. As a result, the SHGIS website develops into a long-term sustainable research tool and a cumulative, searchable digital archive.

Best Practice 3: GIS & Mapping for the City of San Luis Obispo, California

This project\(^{16}\) was designed by the administration of the City of San Luis Obispo, California. The GIS technology provides a visual and geographic platform for managing urban operations and a framework for information sharing. Therefore, this project provides an interactive platform for users to download PDF maps or view online interactive maps to obtain city information, such as zoning, land use, historical sites, police incidents, and more. Moreover, users can also Download GIS data from the ESRI Online Open Data portal for making their personal GIS analyses.

In terms of visualisation of the city's historical and cultural heritage, the most unique and rarest historical sites were marked on the map in red and blue, as showed in Figure 16. Users can quickly and clearly learn the location of these historical sites, as well as their appearance. This can help

\(^{15}\) http://shgis.nus.edu.sg/chinese-temples/

\(^{16}\) https://gis.slocity.org/HistoricMapTour/index.html
users to understand the spatial distribution of the city's historical and cultural heritage and play a positive role in the study of the city's history and culture.

Figure 16. GIS & Mapping for Historic Properties in San Luis Obispo, California

**Conclusion**

Information visualisation facilitates the access to digital historical resources whose exploration is otherwise difficult time consuming. It can amplify the user’s cognition on computer-supported, interactive, and visual transformed data. Digital history provides access to many previously unavailable resources, offers users with the opportunity to interact with resources in a non-linear manner, changes the role of who can conduct research and how to conduct historical research, thus changing the motivation for historical research. The best practices discussed in this paper serve as examples to engage the digital history international community and share more best practices. Information visualisation helps digital history to improve learning efficiency and collaboration. With participatory approaches, problems and gaps, new insights and decision making can be experienced and fostered.

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