

MIRADAS

WAYS of SEEING

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comunicación

Communication



Drawing by CEM; copyright 1961,
The New Yorker.



comunicación basada en evidencias

Evidence-based evidences

Brian L. Joiner, "Living Histograms," *International Statistical Review*, 43 (1975), 339-340. But, for further developments, see Mark F. Schilling, Ann E. Watkins, and William Watkins, "Is Human Height Bimodal?" *The American Statistician*, 56 (August 2002), 223-229.



Small multiples, whether tabular or pictorial, move to the heart of visual reasoning - to see, distinguish, choose (even among children's shirts). Their multiplied smallness enforces local comparisons within our eyespan, relying on an active eye to select and make contrasts rather than on bygone memories of images scattered over pages and pages.

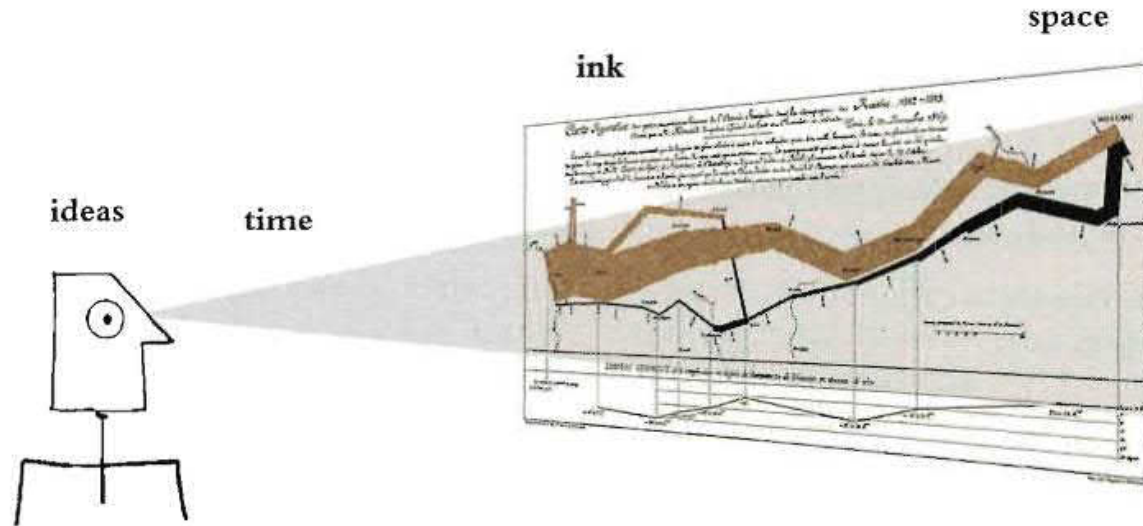
Redrawn from Yumi Takahashi and Ikuyo Shibukawa, *Color Coordination* (Tokyo, 1985), pp. 114-115.

Principles of Graphical Excellence

Graphical excellence is the well-designed presentation of interesting data—a matter of *substance*, of *statistics*, and of *design*.

Graphical excellence consists of complex ideas communicated with clarity, precision, and efficiency.

Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.



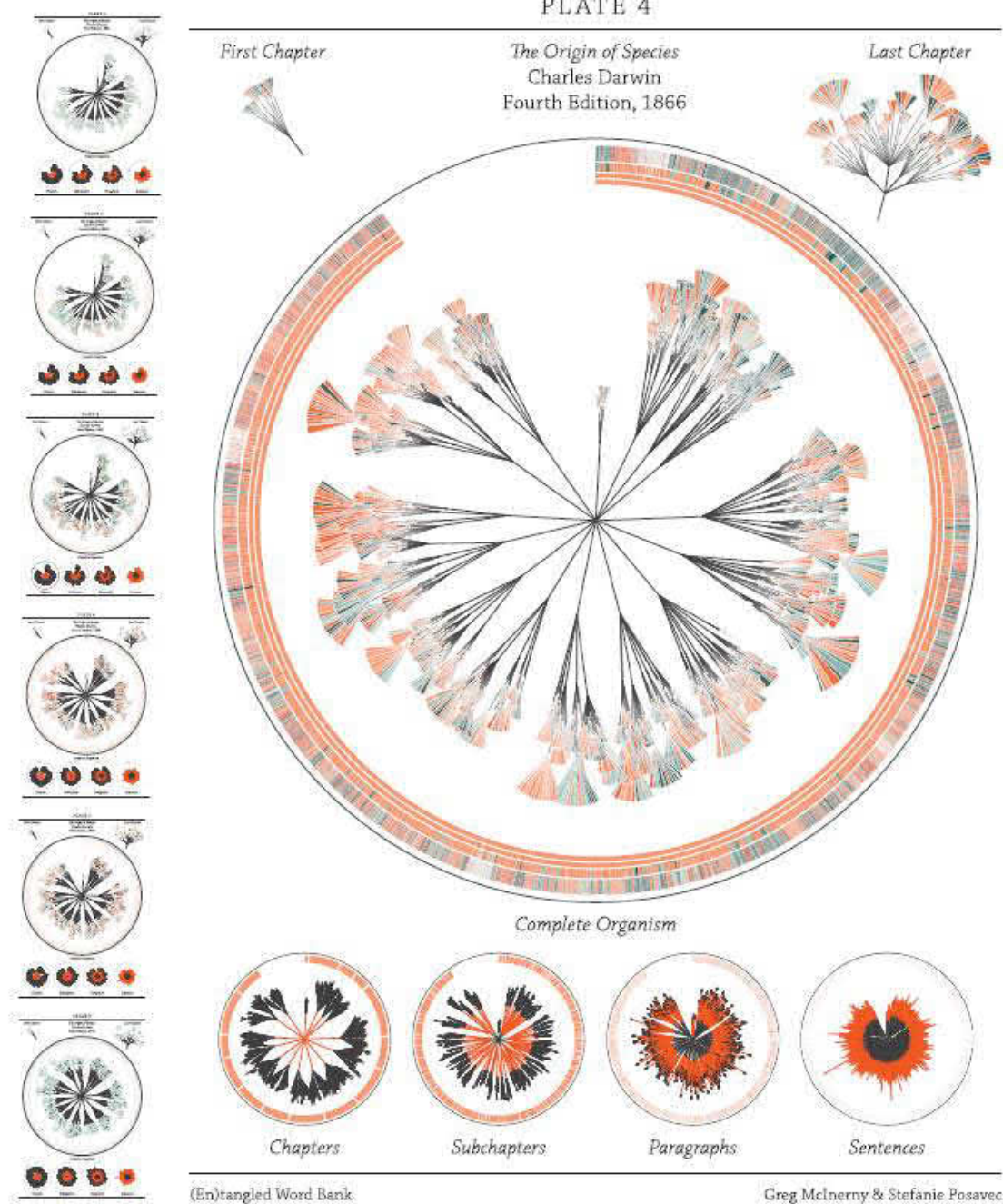
Graphical excellence is nearly always multivariate.

And graphical excellence requires telling the truth about the data.

optimización de la comunicación

communication optimization

Tufte, E. R. (2007). *The visual display of quantitative Information. The Visual Display of Quantitative Information* (Second Edi). Cheshire, Connecticut: Graphics Press.
<http://doi.org/10.1198/tech.2002.s78>



estructuras jerárquicas

árboles

HIERARCHICAL STRUCTURES: TREES



Stefanie Posavec and Greg McInerney, U.S.:
"(En)tangled Word Bank," 2009.

The series of diagrams represents changes in the six editions of Charles Darwin's *On the Origin of Species*. Chapters are divided into subchapters, subchapters into paragraph "leaves," and, finally, small wedge-shaped "leaflets" stand for sentences. Each sentence is colored in blue if it survives to the next edition, and in orange if it is deleted.

In a nutshell, hierarchical systems are ordered sets where elements and/or subsets are organized in a given relationship to one another, both among themselves and within the whole. Relationships vary according to the field domain and type of system, but, in general, we can describe them by the properties of elements and the laws that govern them (e.g., how they are shared and/or related).

In the seminal article "The Architecture of Complexity," Herbert A. Simon contends that complexity often takes the form of hierarchy and, as such, hierarchy "is one of the central structural schemes that the architect of complexity uses."¹ Examples of hierarchical representations abound in the social and natural sciences throughout time up to today. According to Chen, "Visualizing hierarchies is one of the most mature and active branches in information visualization."²

In Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>

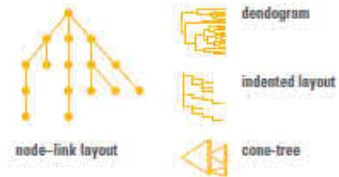
REPRESENTATION

Looking at hierarchical structures over time, it becomes apparent that ordered datasets are represented visually in two basic graphical forms, which sometimes are also combined: stacked and nested schemes.

In stacked schemes, the elements are arranged in a directional relationship to one another: vertically, horizontally, or centrally (superior/inferior, center/periphery). In many instances, lines connect the elements in the set. Lines are one-dimensional visual elements described by their length and also provide directionality. Different geometries have been used to display stacked schemes, especially with recent computational models such as cone trees and hyperbolic views, for example.³

Elements in nested schemes are positioned within containers assembled according to their interdependency and subordination. The container, often a two-dimensional plane, provides the grouping

CARTESIAN SYSTEMS



POLAR SYSTEMS



OTHER GEOMETRIES



The table provides a summary of hierarchical structures used in diverse fields over time. With the increasing accessibility of data in the digital age, and the need to represent trees with huge amounts of leaves, methods are constantly being devised to solve readability issues of hierarchical representations in the constrained spatial computer screens. Most methods use interactivity to enhance navigating between macro and micro scales of trees with large depth and breadth. For example, degree of interest trees use "focus + context" strategies to interactively navigate large trees by allowing filtering of nodes to display or collapse, as well as semantic zooming. These and other approaches for navigating large trees with text are investigated in chapter 6, Textual Structures.

and association of elements. Known examples are Venn diagrams and treemaps.⁴ The latter is examined in closer detail at the end of this chapter.

VISUAL HIERARCHIES

It might sound like a tautology, but to effectively visualize hierarchical systems we need a well-defined hierarchical visual encoding system. In the art and design fields, we refer to hierarchy of visual elements mostly in relation to emphasis and attention, for example, as a means to help the eyes follow a certain direction or purpose. It is common to find the term *contrast* rather than *hierarchy* in art and design literature. Dondis in his seminal *A Primer of Visual Literacy* considers contrast as the prime visual technique: "In the process of visual articulation, contrast is a vital force in creating a coherent whole. In all of art, contrast is a powerful tool of expression, the means for intensification of meaning and, therefore, of simplification of communication."⁵

Whatever the term—visual hierarchy or contrast—to further understand the implication of how we visually encode data, it is necessary to first briefly examine how our visual perception and cognitive systems work.

SPATIAL ENCODING

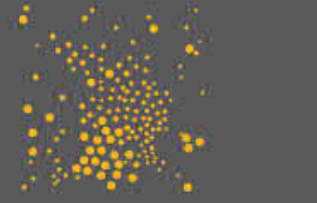
We process spatial properties (position and size) separately from object properties (such as shape, color, texture, etc.).⁶ Furthermore, position in space and time has a dominant role in perceptual organization, as well as in memory.

It is perhaps no coincidence that the ancient "art of memory" relied on spatial information for augmenting long-term memory.⁷ Although the method called mainly for the creation of internal representations to enhance memorization and recollection, it is worth referring to its basic procedures here. The rules varied throughout its history, but, overall, the method proposes the use of an ordered sequence of *loci* as placeholders for concepts and of "active" visual images to stand for subject matters. It is quite fascinating how much these "invisible" mnemonic devices share with external data representations: an artificial and ordered system made out of visual elements, properties, and spatial relations.

Proximity

Proximity describes the tendency to group visual elements that are near one another into a perceptual unit. For example, we perceive the same six elements below as forming different groups:

||||| = 1 group = word
||| ||| = 2 groups = two words



Proximity relates to locational characteristics and is essential to how elements are spatially associated, whether intentionally or not. Note how easily we detect groups and how we tend to make sense of the perceived patterns in the image above with randomly generated sets of dots.

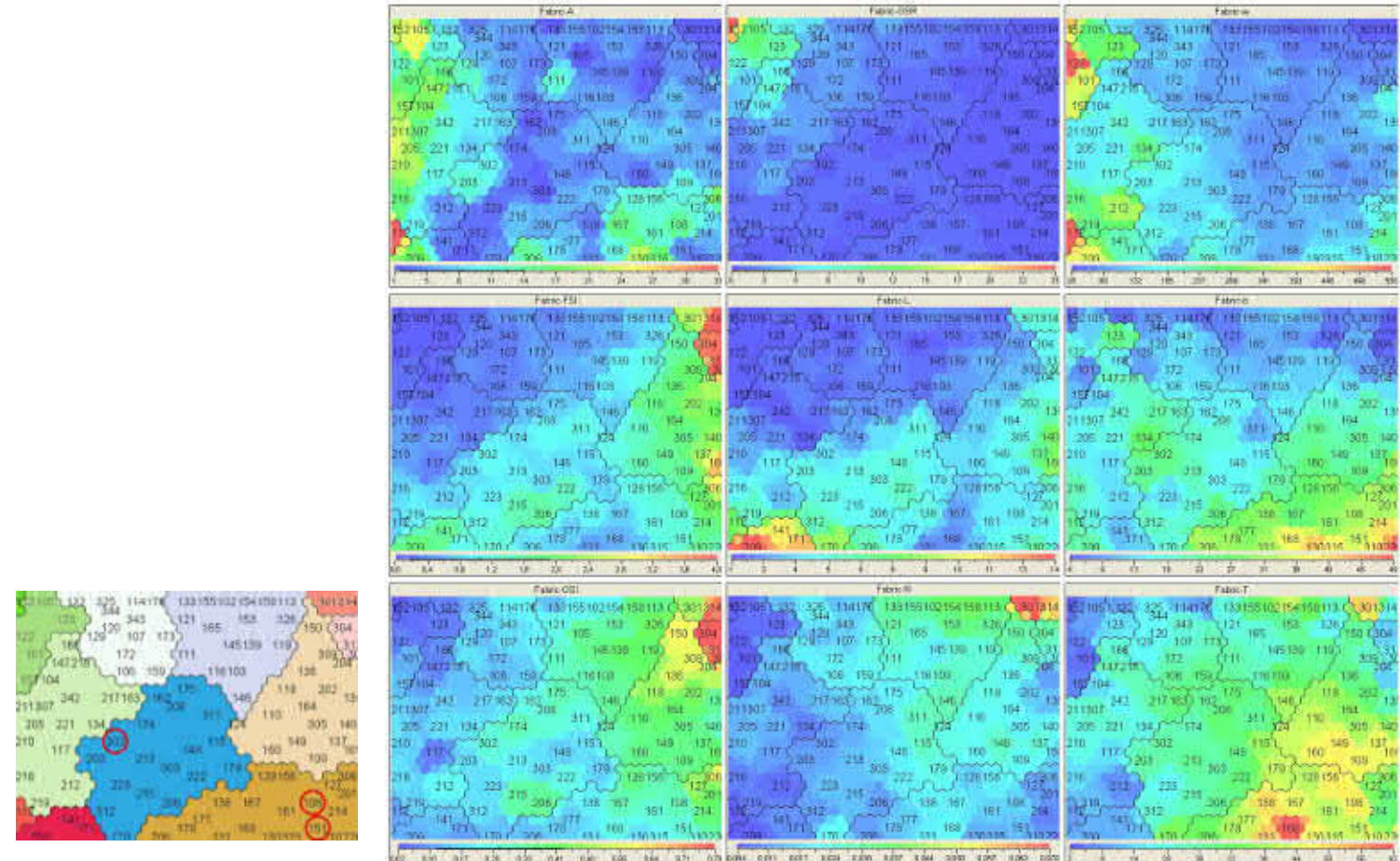
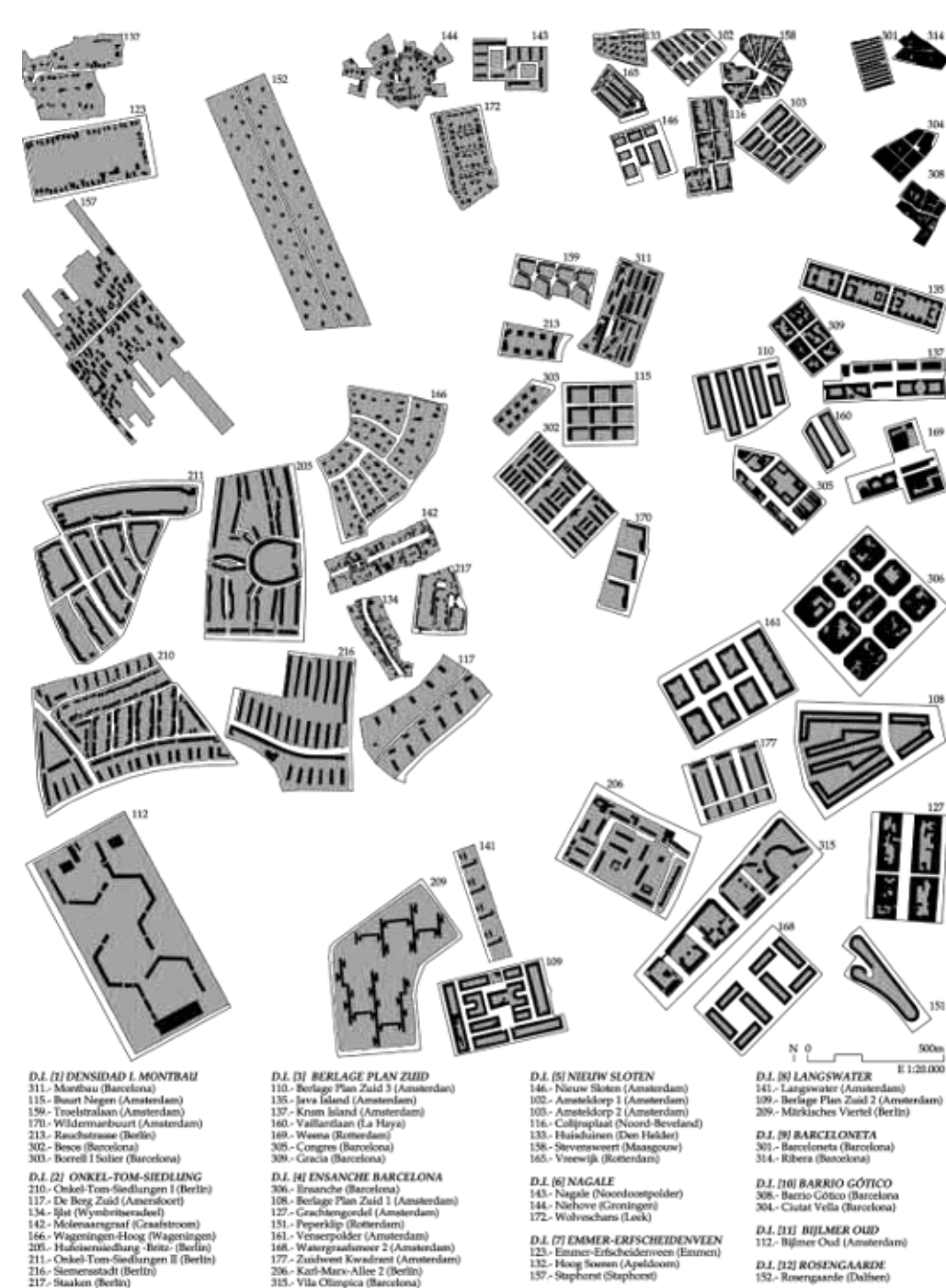


The difference between the images above is that one is rotated 90 degrees in relation to the other. Otherwise, they are identical. Note how we perceive rows in the first one and columns in the second. The space between dots makes us perceive the dots grouped as linear units in the horizontal or vertical direction.

In visual displays, it is crucial that we locate information that is conceptually related spatially close together. Spatial proximity will facilitate the detection and search for associated data.



The County of London Plan de 1943 de Patrick Abercrombie.
Simplificación de las comunidades.
Simplification of Communities
Fuente | Source: Wright, 2008.

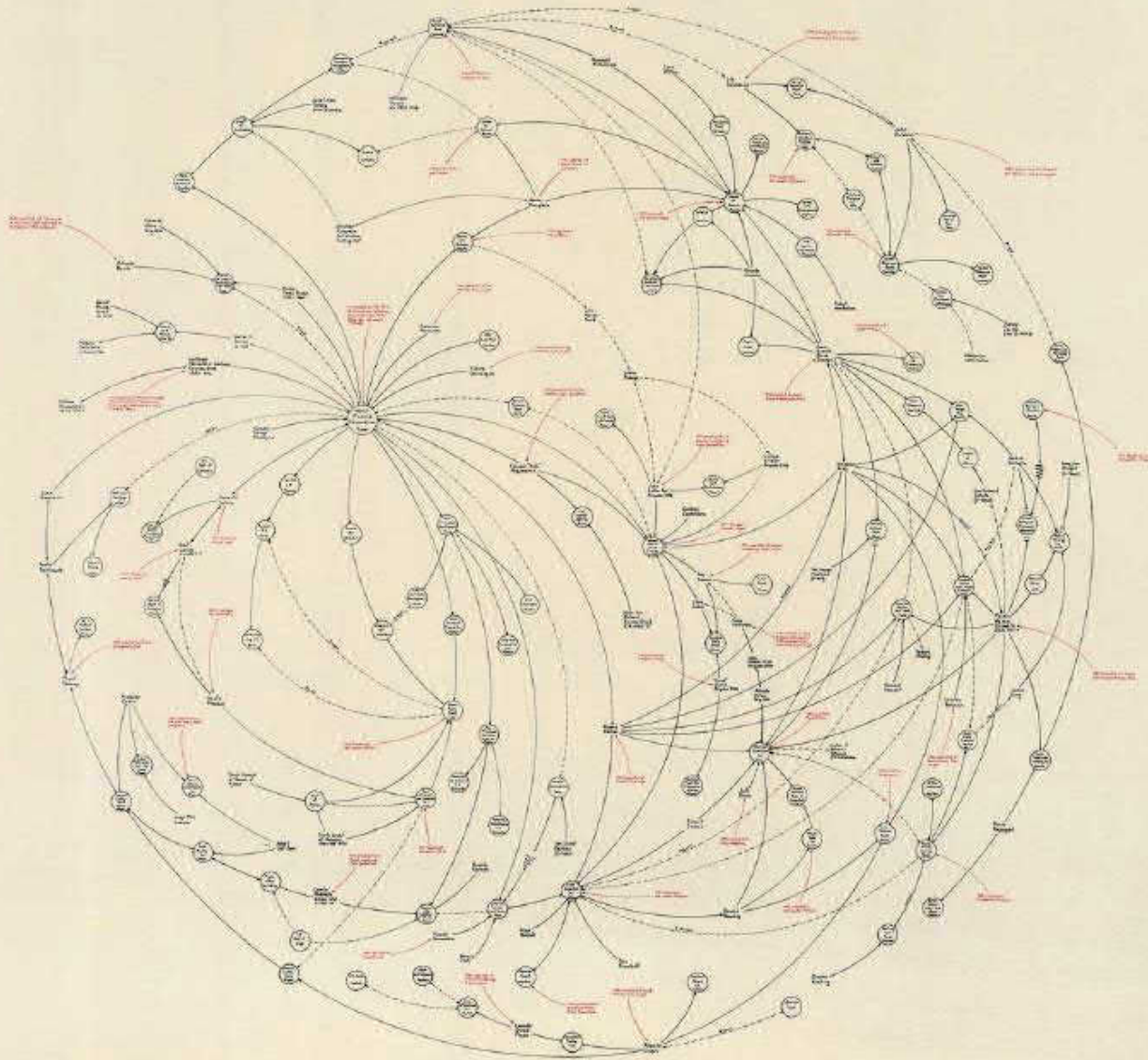


ABARCA-ALVAREZ, F.J.; OSUNA PÉREZ, F. Cartografías semánticas mediante redes neuronales: los mapas auto-organizados (SOM) como representación de patrones y campos. *EGA. Revista de expresión gráfica arquitectónica*, n. 22, p. 154-163, nov. 2013. ISSN 2254-6103. Disponible en: <http://dx.doi.org/10.4995/ega.2013.1692> .

estructuras relacionales

RELATIONAL STRUCTURES: NETWORKS

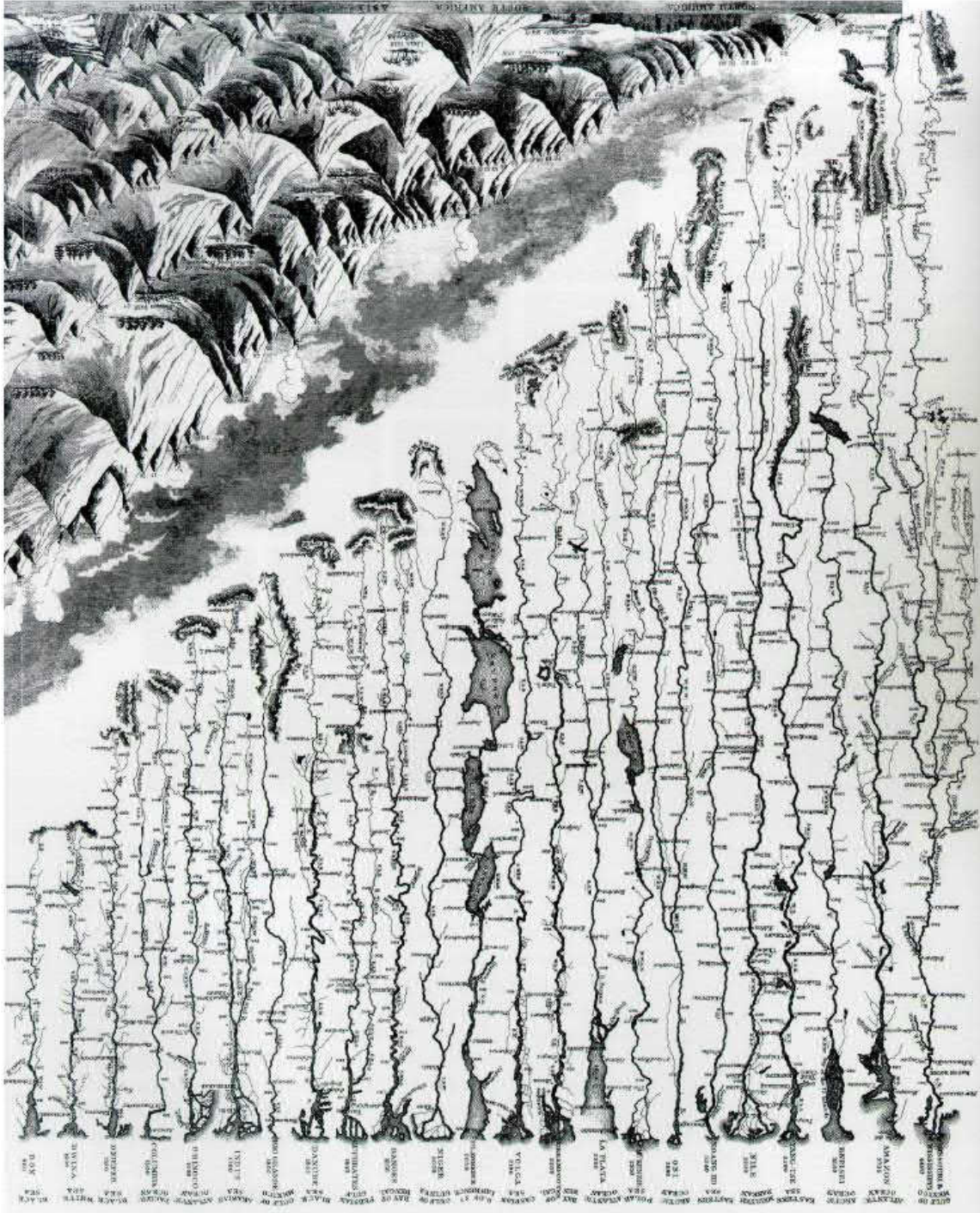
redes



Mark Lombardi, U.S.: *World Finance Corporation and Associates, c. 1970-84, Miami-Ajman-Bogota-Caracas (7th version), 1999.*

American artist Mark Lombardi began a series of drawings in 1994 that he called Narrative Structures, as he explains, "Each consists of a network of lines and notations which are meant to convey a story, typically about a recent event of interest to me, like the collapse of a large international bank, trading company or investment house. One of my goals is to map the interaction of political, social and economic forces in contemporary affairs."¹³ The drawing reproduced here is one among several versions Lombardi created to depict the scandal involving the WFC and the central role it reputedly played in the trafficking of Colombian drugs. Robert Hobbs explains, "An important subtext of this work and other Lombardi pieces... is the wide-ranging collusion involved in global crimes."¹⁴

As the name indicates, relational structures organize data for which relationships are key to the system being visualized. Or to put it another way, there is much that can be learned by studying the patterns of connections between elements in the system—that is, the network of systems. Shneiderman and colleagues provide a good example in the context of social studies: "The focus of social network analysis is between, not within people. Whereas traditional social-science research methods such as surveys focus on individuals and their attributes (e.g., gender, age, income), network scientists focus on the connections that bind individuals together, not exclusively on their internal qualities or abilities. This change in focus from attribute data to relational data dramatically affects how data are collected, represented, and analyzed. Social network analysis complements methods that focus more narrowly on individuals, adding a critical dimension that captures the connective tissue of societies and other complex interdependencies."¹⁵



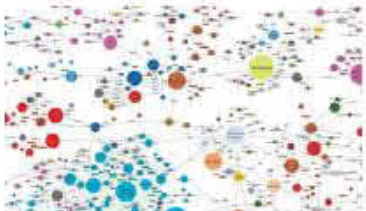
Joseph Hutchins Colton, *Johnson's New Illustrated Family Atlas with Physical Geography* (New York, 1864), pp. 10-11.

most common types of network layouts



LINEAR:

Nodes are organized linearly and the links are usually arcs connecting nodes.
Con: It's hard to identify clusters and is only feasible for small datasets.



FORCE DIRECTED:

There are many algorithms that use an iterative process to locate nodes according to physical forces.
Con: There are too many node occlusions and link crossings in dense areas.



CIRCULAR:

Nodes are organized around the circumference and usually grouped by categories. Links cross the circle and are usually bundled so as to simplify the crossings.
Con: It's hard to identify clusters.



SANKEY TYPE DIAGRAMS:

Nodes are organized vertically and the links horizontally.



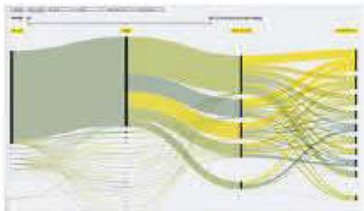
FORCE DIRECTED:

Force directed graphs centered on a node.



POLAR OR RADIAL:

Nodes are organized around a central node, with their position related to the number of hops it takes to reach it.



most common layouts centered on nodes



COMMUNITY STRUCTURE:

The focus is on community structures.



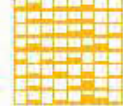
GEOGRAPHY BASED:

Spatial location of a node is provided by its geo position.



MATRIX:

Grid of nodes with link information positioned within the cell.



RADIAL COMMUNITY STRUCTURE:

Nodes are organized around a central community.



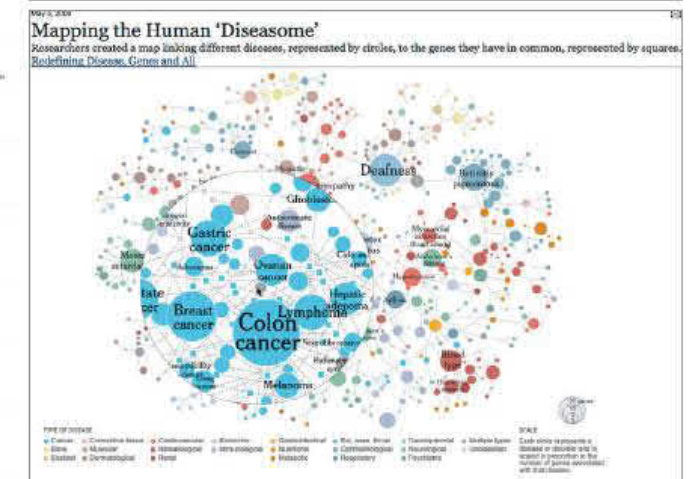
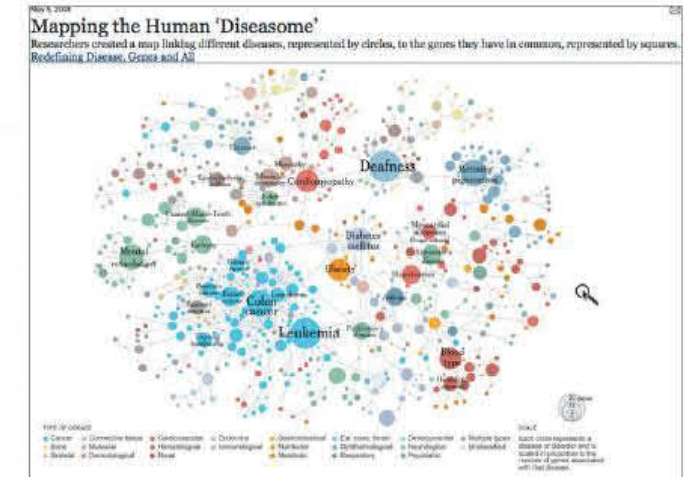
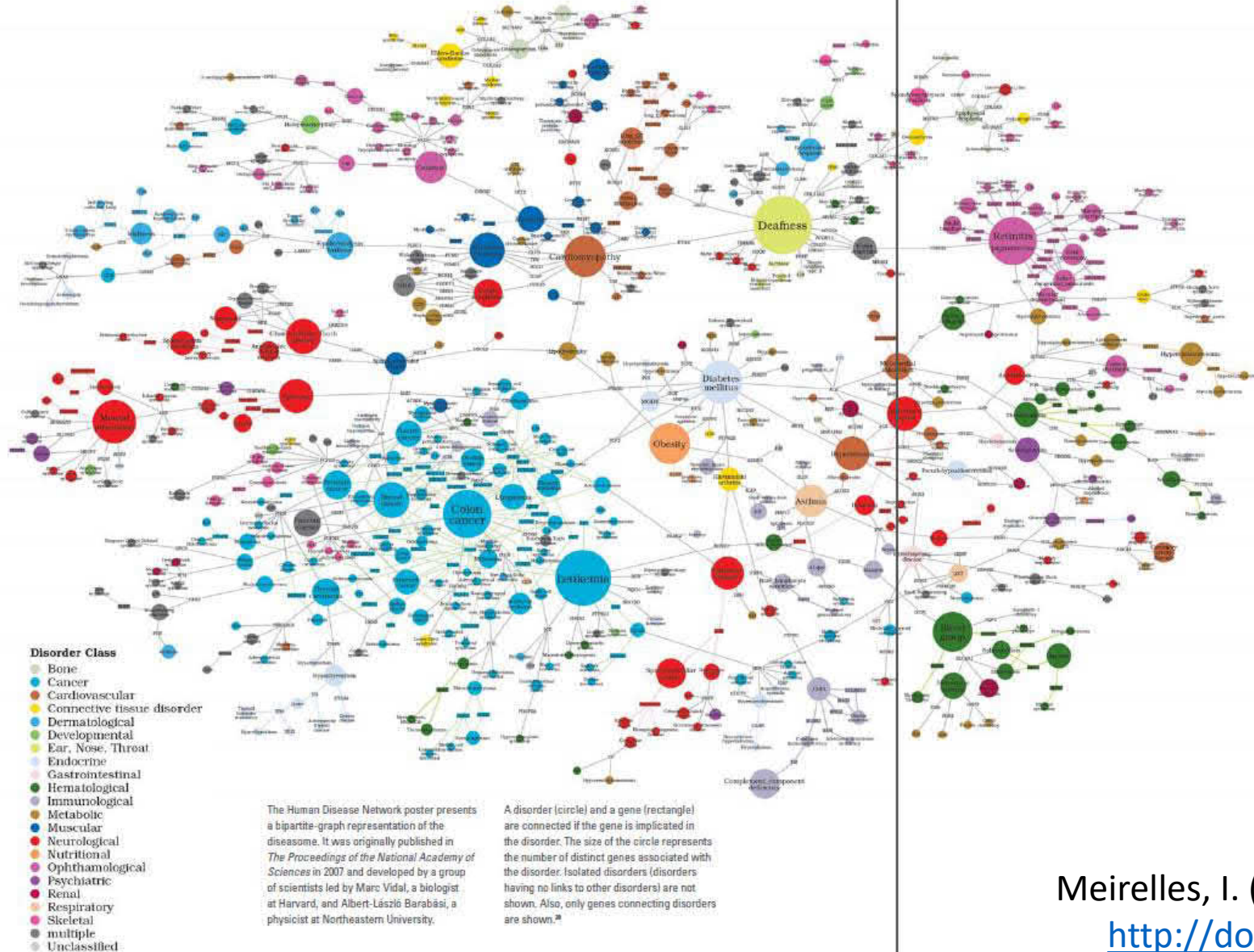
Like Galileo's telescope (1564–1642), Hooke's microscope (1635–1703), or Roentgen's x-rays (1845–1923), new information analysis tools are creating visualizations of never before seen structures. Jupiter's moon, plant cells, and the skeletons of living creatures were all revealed by previous technologies. Today, new network science concepts and analysis tools are making isolated groups, influential participants, and community structures visible in ways never before possible.

Ben Shneiderman

Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>

The human disease network

Goh K-I, Cusick ME, Valle D, Childs B, Vidal M, Barabási A-L (2007) *Proc Natl Acad Sci USA* 104:8685-8690



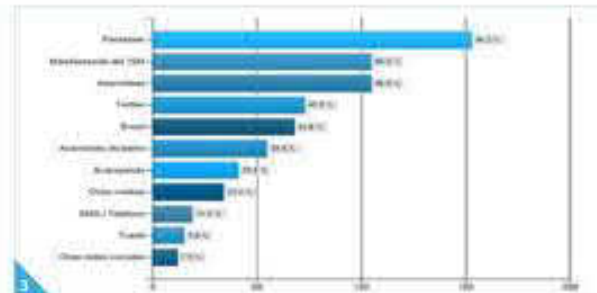
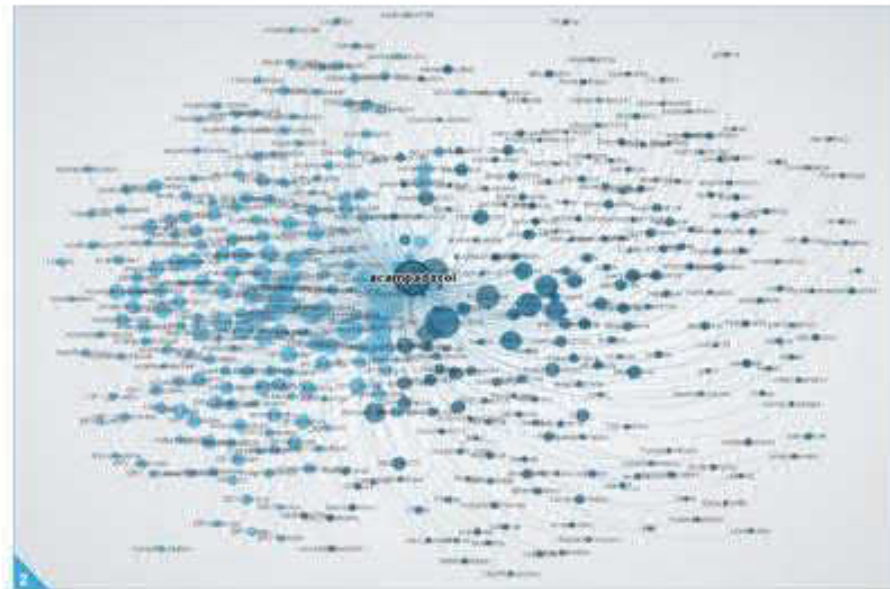
In 2008, the *New York Times* published the scientific discovery and created an interactive disease map to accompany the article "Redefining Disease, Genes and All."

www.nytimes.com/interactive/2008/05/05/science/20080506_DISEASE.html

Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>

DIGITAL

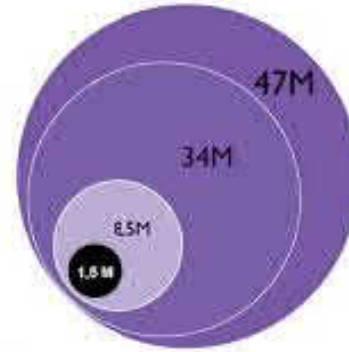
The Internet is a democratic space, a platform where every citizen can express freely and horizontally, a space where ideas flow in every direction. The network, with its different attributes, provides the framework to test new models of collective creation and self-organization and to boost social identities. The digital sphere is an essential infrastructure that allowed organization and communication for sparking the process into reality.



1. Google Heat Map of Twitter in 2013. GDXT 2013 Data on Events, 3 weeks and Time by J. B. <http://revolution.rwth-aachen.de/> 2. Map of 400 most relevant Twitter accounts to follow the #15manicamp. by M. López. <http://www.humanidades.com/> 3. Forms of participation in #15M from study Technopolis: The culture of innovation in Madrid. The #15M network appears as a new paradigm of distributed politics by J. Tóiz and others in the *Deliberative 15M research group at IN3-UPC* 4. https://twitter.com/a_urfao after comparing Twitter Square and Plaza del Sol on Twitter, at the beginning of the protests

Ecosistema Urbano. Planning for Protest
Things we could learn from #15M in Madrid

DIGITAL



Ecosistema Urbano. Planning for Protest

Things we could learn from #15M in Madrid

CIRCULAR + LINEAR + TREEMAP + FORCE DIRECTED

Visualizing Information Flow in Science

<http://well-formed.eigenfactor.org>

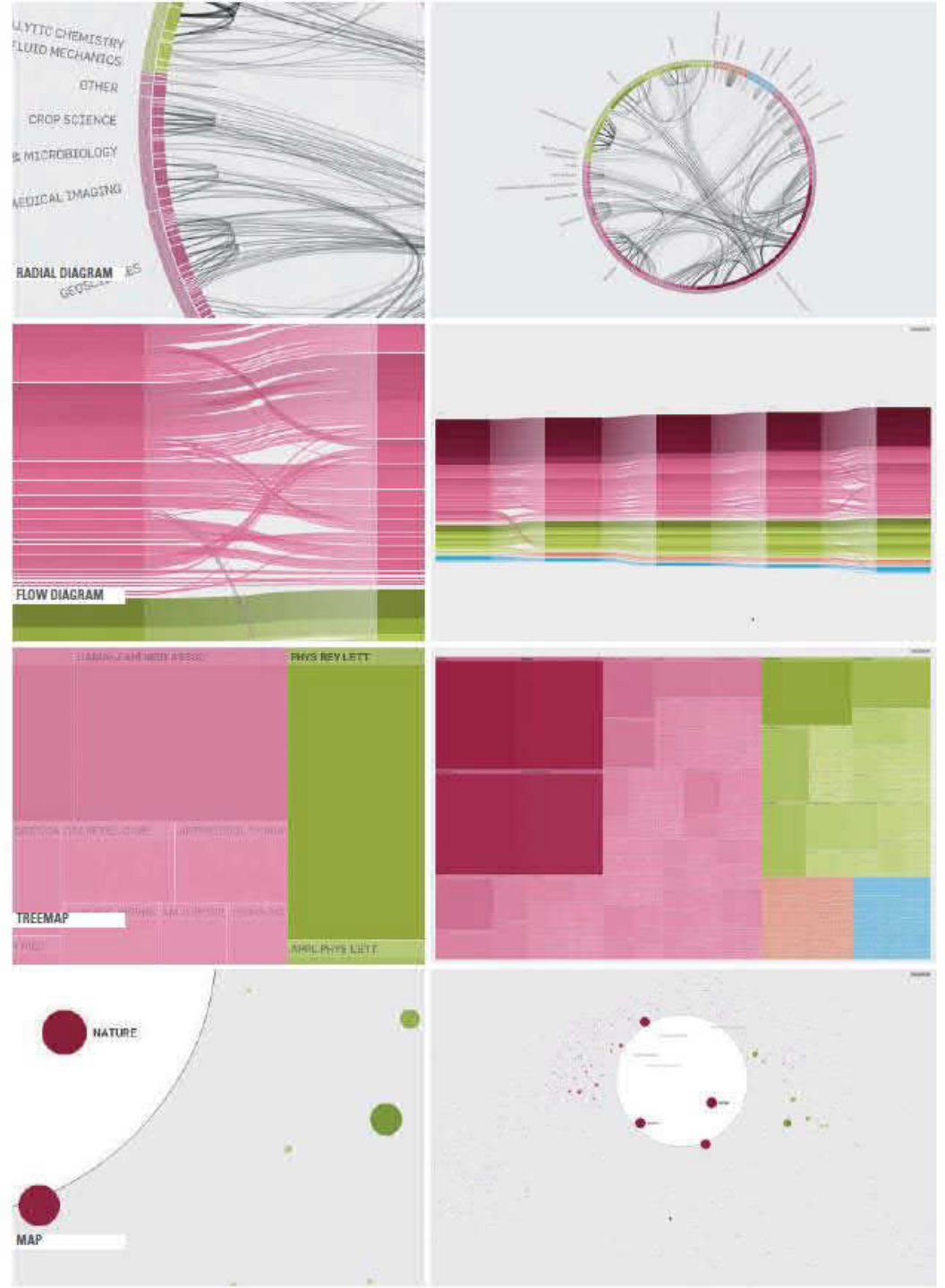
The visualization "well-formed.eigenfactor: Visualizing information flow in science" was devised by Moritz Stefaner in collaboration with Martin Rosvall, Jevin West, and Carl Bergstrom at the Bergstrom Lab, University of Washington.

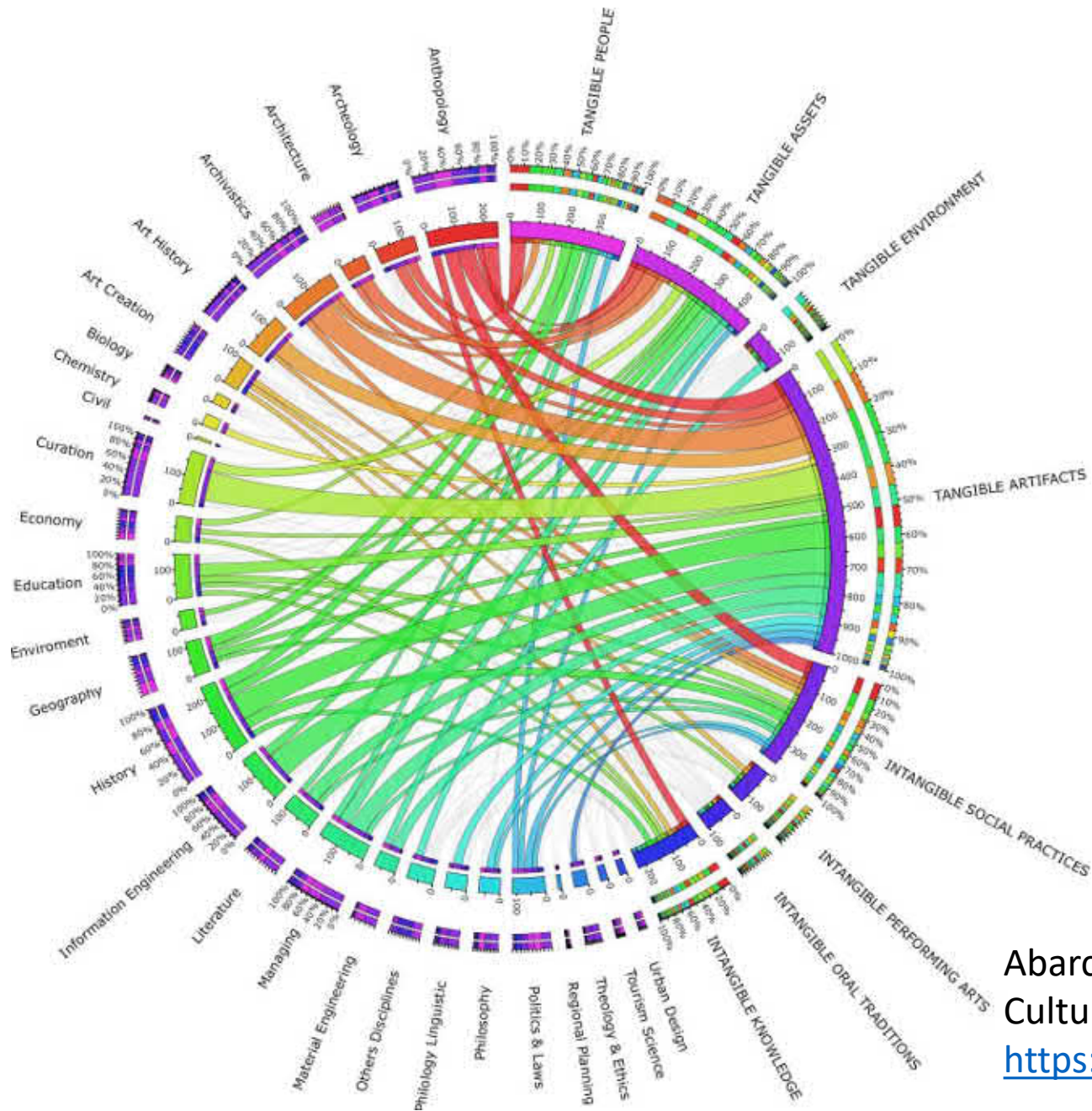
The project examines a subset of the citation data from Thomson Reuters' *Journal Citation Reports* from 1997–2005. It depicts 400 journals and around 13,000 citation edges, which ensures coverage of the top journals in each field.

The Eigenfactor® project calculates a measure of importance for individual journals—the Eigenfactor score—while also measuring the citation flow and a hierarchical clustering based thereon. The authors explain how they approached the problem of visualizing the citation network, saying, "Our project extends the visual vocabulary in this area: on the one hand, by repurposing existing techniques, such as radial edge bundling and treemaps; on the other hand, by inventing novel approaches like magnetic pins as flow indicators and an alluvial diagram to represent change over time in cluster structure."²⁴

Stefaner created a set of four interactive visualizations, and each allows one to explore emerging patterns in the scientific citation network: citation patterns, changes over time, clustering, and map. All visualizations were created in 2009 using Flare, the ActionScript library for creating visualizations that runs in the Adobe Flash Player.

AUTHORS	Moritz Stefaner (visualization), Martin Rosvall, Jevin West, and Carl Bergstrom (Eigenfactor score)
COUNTRY	Germany and U.S.
DATE	2009
MEDIUM	Online interactive application
URL	http://well-formed.eigenfactor.org
DOMAIN	Scientific citation network
TASK	To provide an overview of information flow in science
STRUCTURE	Set of four visualizations, each with a different structure
DATA TYPE AND VISUAL ENCODING	
Categorical:	Four scientific fields: medical sciences, natural sciences, formal sciences, social sciences
Encoding:	Color: Purple, green, blue, orange
Quantitative:	Eigenfactor score
Encoding:	Radial diagram: Length of arc segment
	Flow diagram: Thickness of line
	Treemap: Area size of squared shape
	Map: Area size of circle
Quantitative:	In and out citation flows for each journal
Encoding:	Radial diagram: Line width and opacity
	Flow diagram: Not encoded
	Treemap: "Magnetic pins" size
	Map: Area size of circle
Temporal:	Five years in the dataset
Encoding:	Flow diagram: Horizontal axis



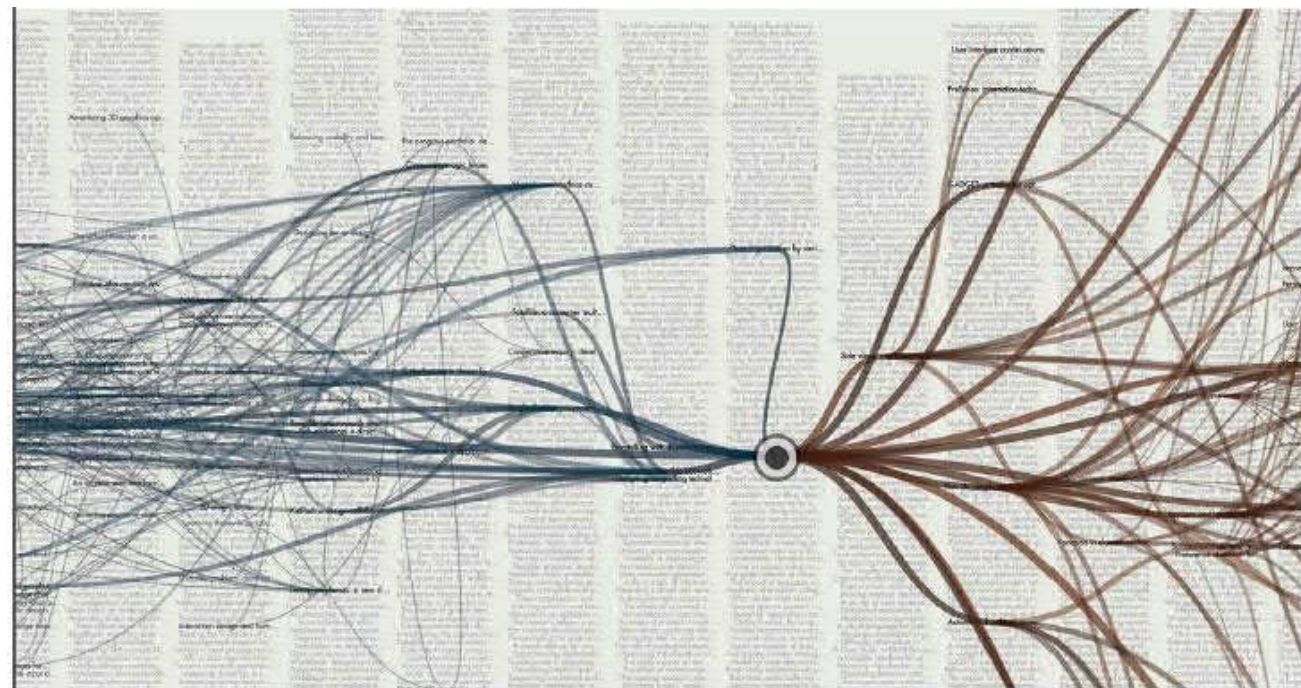
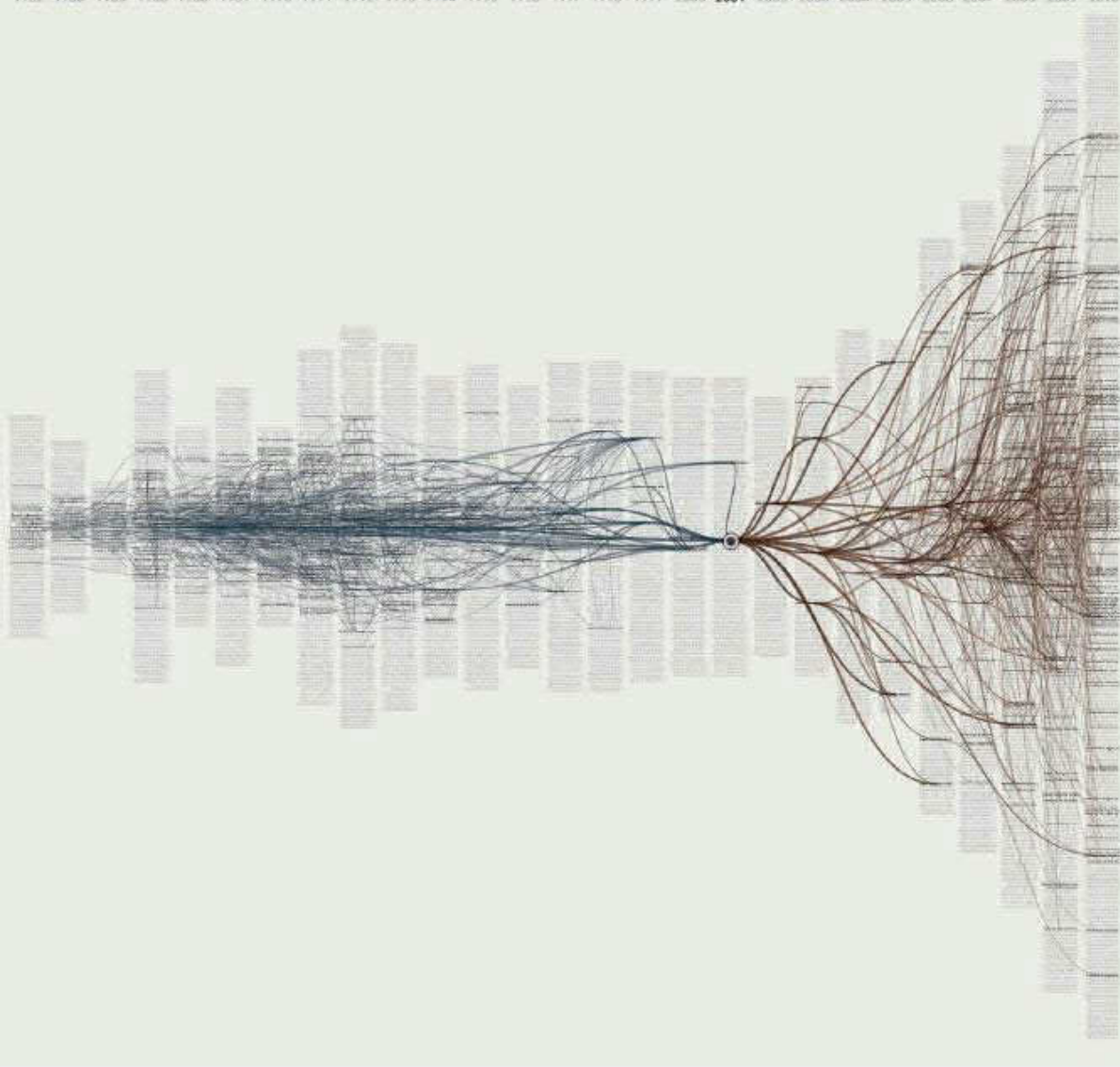


Abarca-Alvarez, F.J., Staniscia, B. & Montanari, A. (2016)
 Cultural Heritage in the framework of European Research Projects
<https://doi.org/10.13140/RG.2.2.26341.04321>

CITEOLOGY

3,502 CHI/UIST PAPERS AND THE 11,699 CITATIONS BETWEEN THEM

1982 1983 1985 1986 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

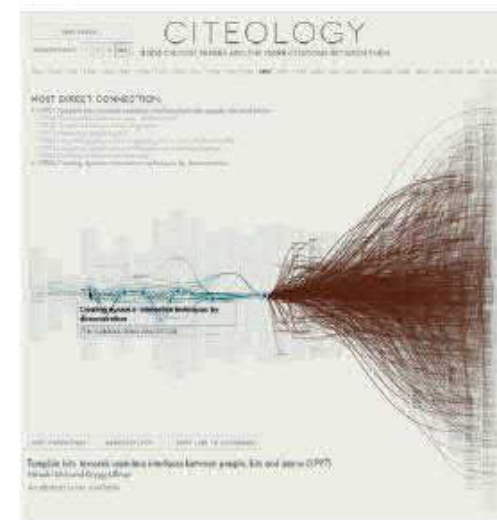


Justin Matejka, Tovi Crossman, and George Fitzmaurice
(Autodesk Research), Canada: "Citeology," 2011.

Citeology is an interactive visualization application that looks at the relationships between research publications through their use of citations. In total, 11,699 citations were made from one article to another within the collection of 3,502 papers published at two series of conferences by the Association for Computing Machinery (ACM) between the years 1982 and 2010: the Conference on Human Factors in Computing Systems (CHI) and the Symposium on User Interface Software and Technology (UIST) on Computer-Human Interaction.

Time runs horizontally and is measured in years, with the omission of 1984 and 1987, when conferences didn't occur. Papers are organized vertically by year and positioned starting at the center of each column and sorted by the frequency of citations. In other words, the papers with the largest number of citations are found at the horizontal center of the visualization. The initial twenty-five characters of papers form the lines that represent each accordingly. Because the type is too small to read on the screen, hovering over one of the lines provides the paper title. When a paper is selected, the program draws its citation network, rendering in blue connections to papers cited in the paper (descendants) and in red papers that cited it (ancestors). Thickness and opacity of the connecting lines encode age, such that lines connecting close generations are thicker and opaque in contrast to thinner and more transparent lines for further generations. The shortest path between two papers can be found by means of interactions once a paper has been selected and its *citeology* rendered.

www.autodeskresearch.com/projects/citeology



LINEAR STRUCTURE

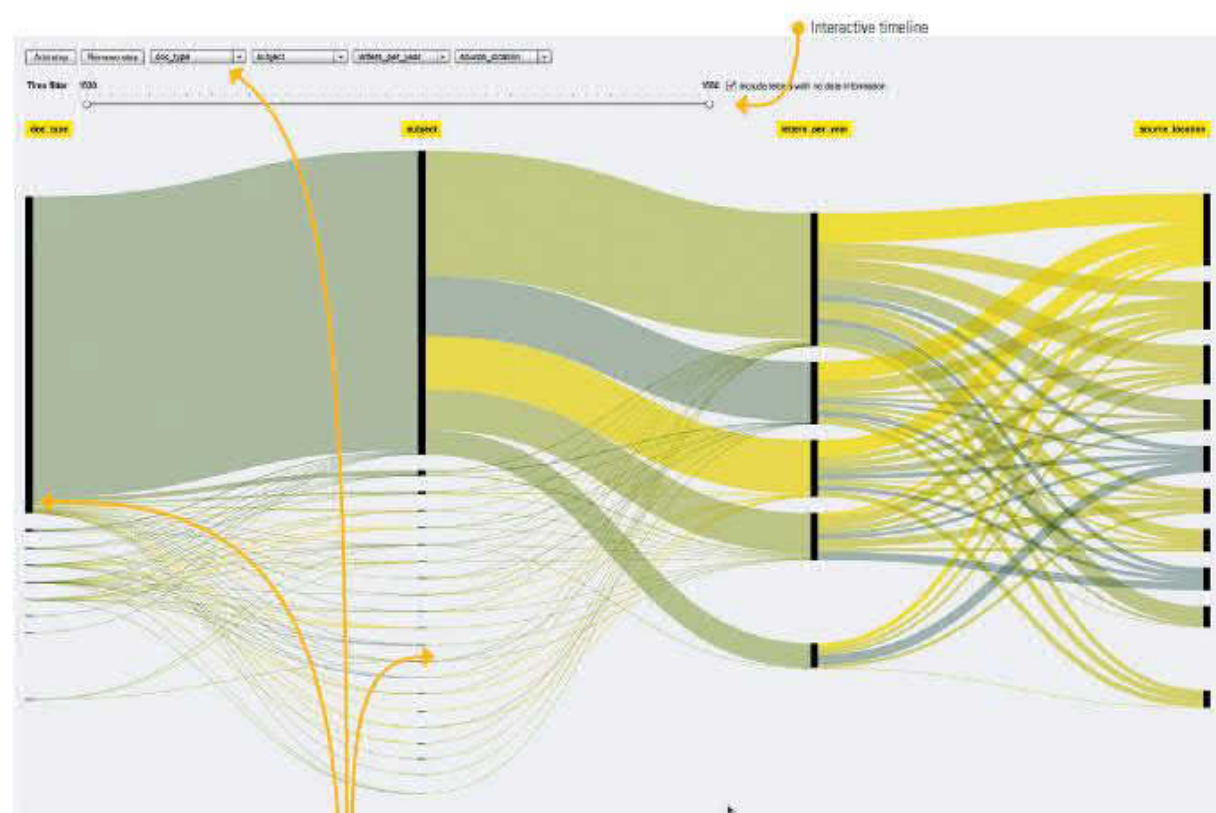
Fineo

<http://fineo.densitydesign.org>

First published in 1898 to depict energy flows and energy losses in a steam engine, the Sankey diagram was named after its creator, the Irish engineer Matthew H. P. R. Sankey.²³ Sankey diagrams are flow diagrams in which the widths of bands are scaled to the corresponding quantities of flow. Common examples are found in energy and financial systems, because they require understanding of the flow distribution of a phenomena.

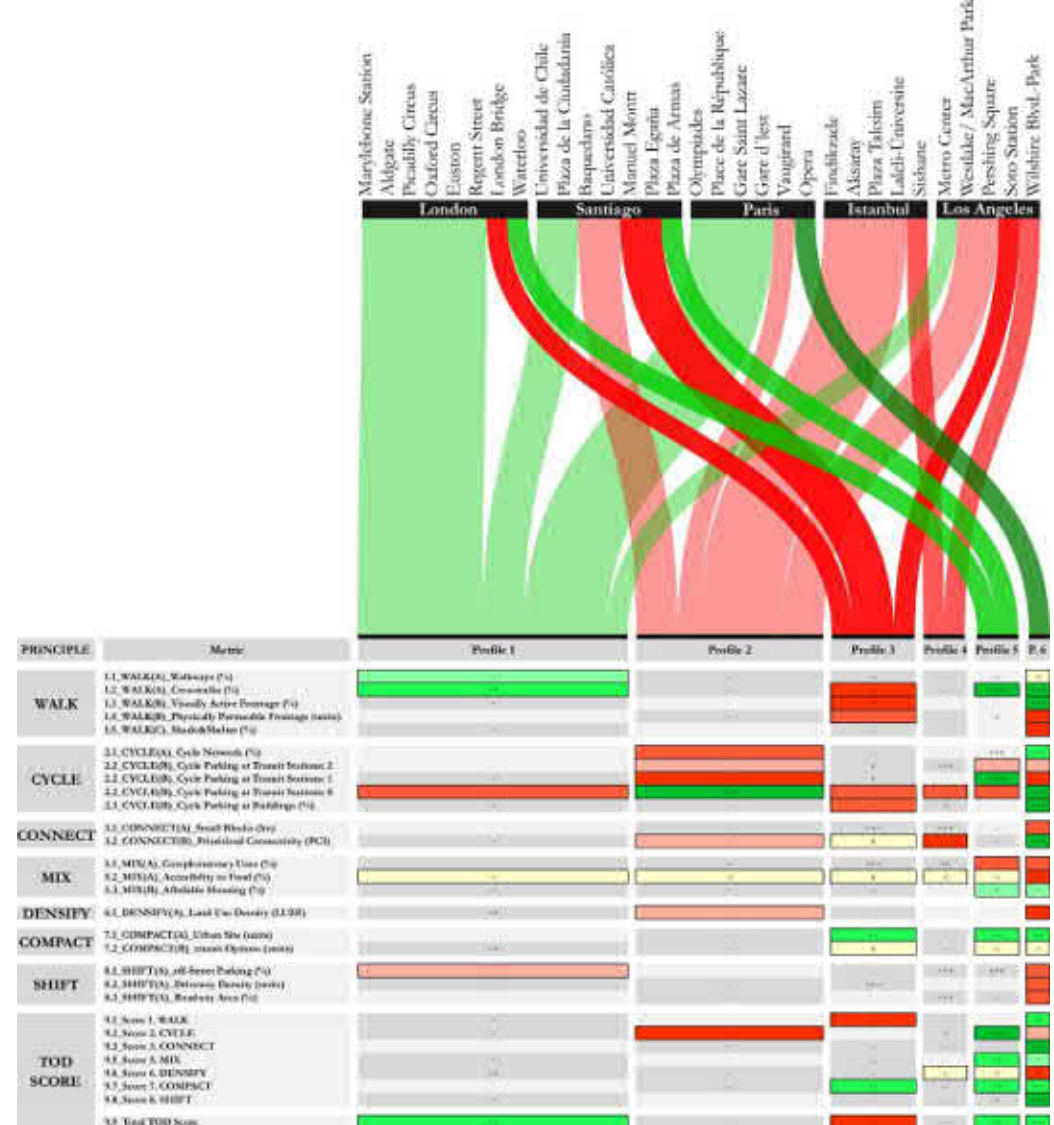
Fineo is an interactive application created by DensityDesign Research Lab in 2010. The exploratory visualization uses the structure of a Sankey diagram with the purpose of representing relations between multidimensional categorical data. Sankey diagrams have a networklike structure, with nodes and weighted links. By using the continuous flows of connections, the tool allows easy comparison between dimensions at both local (pairs) and global (all dimensions) levels of the phenomena. The team explains, "Flows in Sankey diagrams act much more like 'rivers' (as opposed to threads) in which you lose memory of the previous steps. This can be useful in those cases in which the user is more interested in relating different data dimensions next to each other more than centering the visualization partition around a leading dimension."²⁴

Bendix and Kosara devised in 2008 the Parallel Sets interactive visualization for exploring categorical data.²⁵ The method extends the parallel coordinates methodology by representing the set of categories along each axis, while scaling the categories according to their corresponding frequencies. Although it is similar at first glance with Parallel Sets, *Fineo* depicts data in a nonhierarchical way. In *Fineo*, axes are independent of each other, and they can be reordered to facilitate comparison between pairs of dimensions, such that one can read the visualization from all directions (left or right).

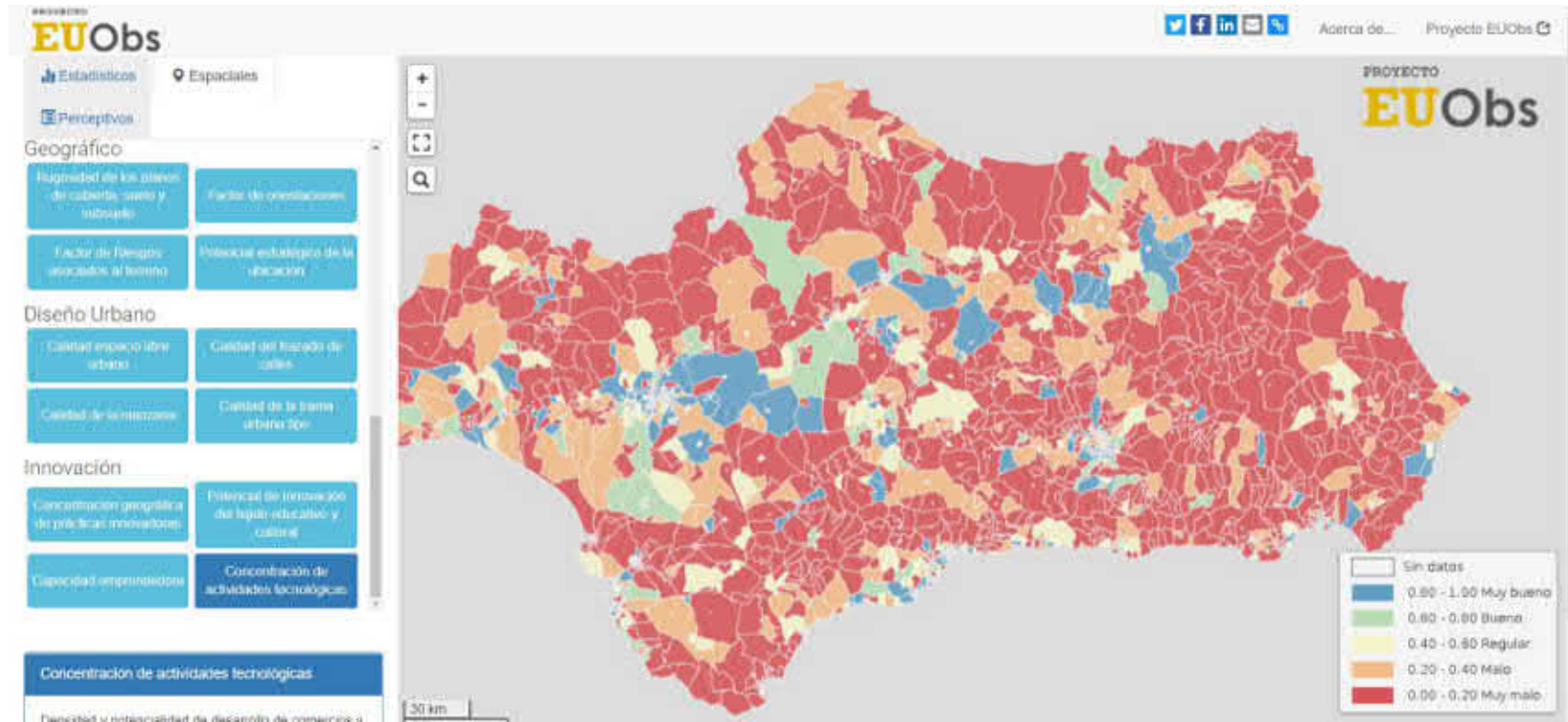
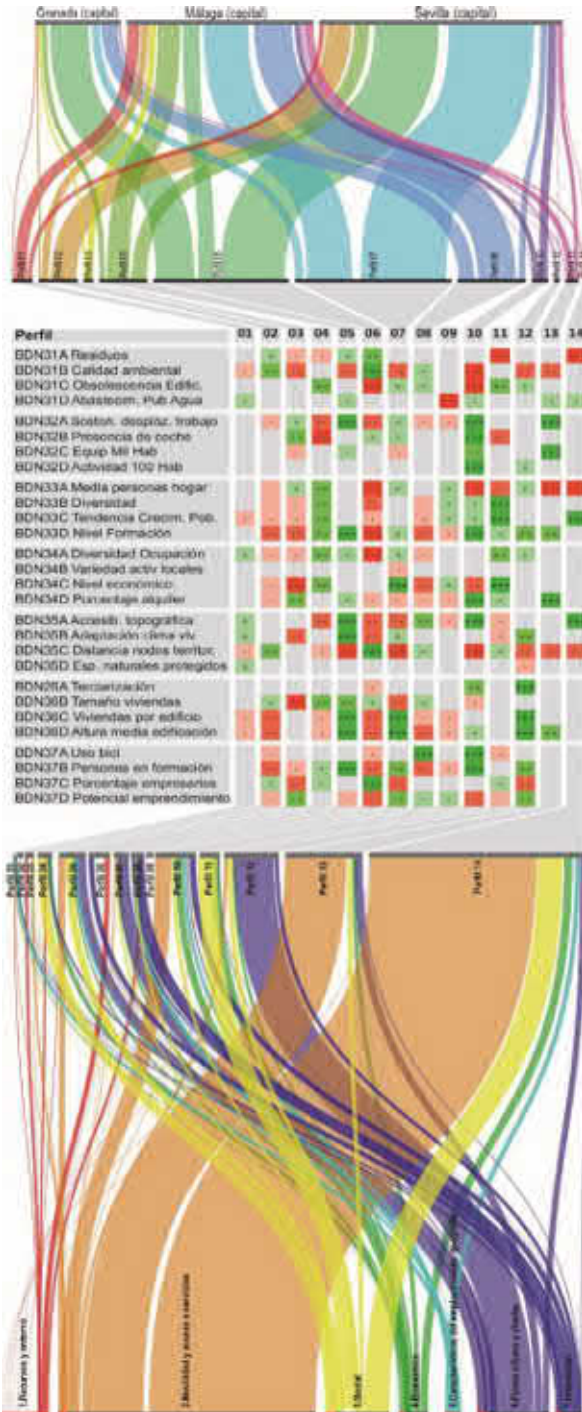


Fineo has a network structure, where nodes are individual categories grouped under a dimension, with the flow lines representing connections. Connections are grouped at every level, thus providing the width between pairs of axes.

AUTHORS	Paolo Ciuccarelli (scientific coordinator), Giorgio Caviglia, Michelle Mauri, Luca Masud, Donato Ricci (researchers), at DensityDesign Research Lab, Politecnico di Milano
COUNTRY	Italy
DATE	2010
MEDIUM	Online interactive application
URL	http://fineo.densitydesign.org
DOMAIN	Categorical data
TASK	To represent relations between multidimensional categorical data
STRUCTURE	Visualization technique of continuous flow of data based on Sankey diagram structure
DATA TYPE AND VISUAL ENCODING	
Categorical:	Main categorical groups. This example uses sample data from the <i>Republic of the Letters</i> project and contains seven main groups (http://fineo.densitydesign.org/mrnl/new/letters).
Encoding:	Vertical axes represent the main categories, each subdivided into subcategories.
Categorical:	Subcategories
Encoding:	Vertically aligned bars (nodes), with the height defined by its frequency of occurrence
Categorical:	Connections between nodes
Encoding:	Line connecting nodes between pairs of vertical axes. Line width corresponds to the frequency of connected nodes. Color codes are categorical.
Temporal:	Years in the dataset. In this case, fifty years.
Encoding:	Interactive timeline acts as a filter in the dataset



Campos-Sánchez, F. S., Abarca-Alvarez, F. J., Serra Coch, G. & Chastel, C. (2019). Comparative assessment on Transit Oriented Development (TOD) level around transport nodes of large cities: Complementary methods of decision support. *EURE Revista Latinoamericana de Estudios Urbano Regionales*. 134 (45). <http://www.eure.cl/index.php/eure/article/view/2711>



Abarca-Alvarez, F.J. Osuna-Pérez, F. Reinoso-Bellido, R. (2017) Identificación de espacios urbanos con mayor calidad de vida. Proyecto I+D+i EUOBs. Junta de Andalucía

Identifying Urban Spaces with a Higher Quality of Life. EUOBs R&D&I Project. Regional Government of Andalusia

Dimensión

Todas

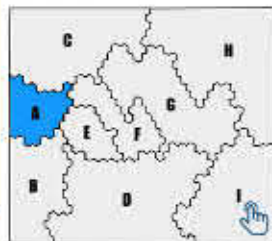
Limpiar Filtro

Dimensión	Variable	A	B	C	D	E	F	G	H	I
07.2 Inseguridad alimentaria y hambre	Come variados tipos de alimentos: Si	-1,75	-1,83	-1,67	-0,65	-0,24	0,15	0,87	1,16	1,33
07.2 Inseguridad alimentaria y hambre	Comi Cuando Tenia Hambre: Si	-1,76	-1,74	-1,23	0,11	-0,19	0,25	0,98	1,88	1,67
07.2 Inseguridad alimentaria y hambre	Ha realizado todas sus comidas sin la necesidad de saltarse alguna: Si	-1,64	-1,43	-1,15	0,11	-0,17	0,17	1,01	1,91	1,85
07.2 Inseguridad alimentaria y hambre	Realiza todas sus comidas: Si	-0,81	-0,88	-0,86	0,37	-0,05	0,21	0,86	1,68	1,89
07.2 Inseguridad alimentaria y hambre	Tiene dinero para comida saludable: Si	-1,63	-1,46	-1,36	-0,49	-0,18	0,09	0,83	1,17	1,43
07.2 Inseguridad alimentaria y hambre	Tiene reservas de comida: Si	-1,69	-1,63	-1,25	0,01	-0,18	0,15	1,00	1,75	1,56
07.2 Inseguridad alimentaria y hambre	Tranquilidad por las reservas de comida: Si	-1,61	-1,53	-1,41	-0,65	-0,21	0,11	0,80	0,94	1,05
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES MOD-SEV): FS	-0,31	-2,17	-3,09	-0,22	-0,27	-0,04	1,04	2,50	2,01
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES MOD-SEV): MOD SEV	2,27	2,11	3,04	0,27	0,04	-0,44	-1,14	-2,71	-2,10
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES)	-0,09	-0,10	-0,11	-0,11	-0,15	-0,16	-0,15	-0,13	-0,12
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): FS	-3,89	-2,03	-2,97	-1,07	-0,29	-0,13	0,74	0,92	0,97
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): MiFS	-1,55	-1,71	-2,53	0,49	-0,07	-0,08	0,15	0,49	0,29
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): MOFS	-0,22	-0,27	0,77	0,71	0,06	-0,23	-0,75	-2,11	-1,53
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): ATELESS	0,01	-0,45	0,60	0,02	0,08	-0,26	-0,66	-2,24	-1,49
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): FEWFOODS	-0,99	-1,54	-2,07	0,81	-0,10	0,11	-0,12	0,32	-0,26
07.3 Escala de Experiencia en Inseguridad Alimentaria	(FIES-Cat2): FOOD SECURITY	-3,89	-2,03	-2,97	-1,07	-0,29	-0,13	0,74	0,92	0,97

A = Tamaño del Efecto en el perfil A

Perfiles de Seguridad Alimentaria de Poblaciones Centroamericanas

Resultados del perfil A

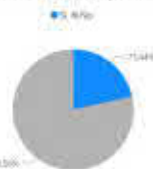


Nº de encuestados del perfil:

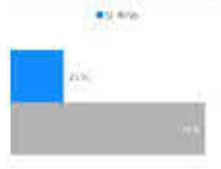
1206



¿Nivel de vida ha mejorado?



¿Satisfecho con el sistema educativo?



¿Control variedad de alimentos debido a que cuenta con dinero u otros medios?



¿Siente tranquilidad por tener suficiente comida ya que cuenta con dinero u otros medios?



GIS4tech (2022) Herramienta para el análisis de perfiles con Inteligencia Artificial “DATAface”.

Perfiles de Seguridad Alimentaria de Poblaciones Centroamericanas

“DATAface,” an AI-powered profile analysis tool.

Food Security Profiles of Central American Populations

<https://dataface.gis4tech.com/GALLUP>

GEOGRAPHY BASED

GLEAMvizwww.GLEAMviz.org

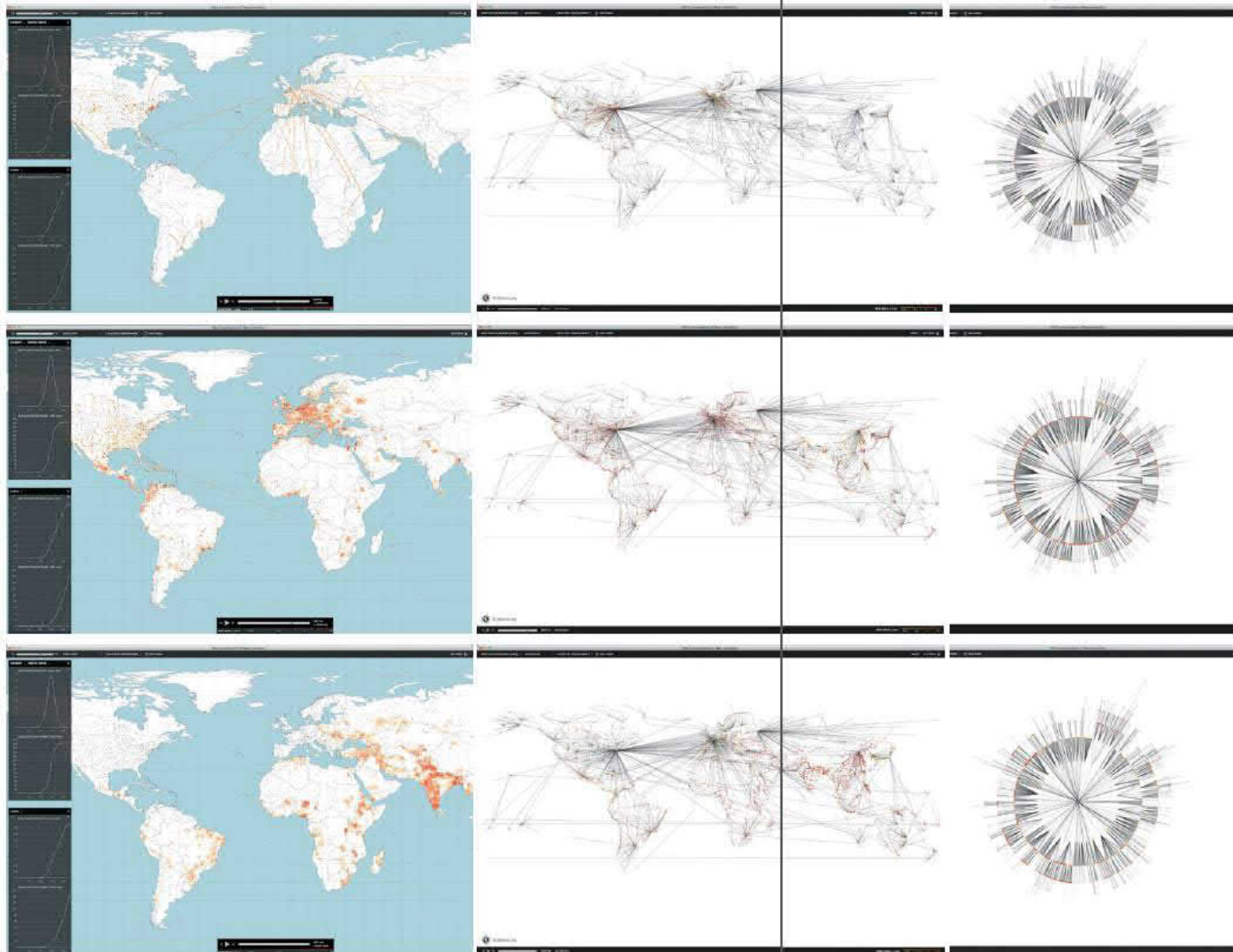
GLEAMviz is a client-server software system that can model the worldwide spread of epidemics for human transmissible diseases such as influenza-like illnesses. GLEAMviz makes use of a stochastic and discrete computational scheme to model epidemic spread called GLEAM—Global Epidemic and Mobility model. The model is based on a geo-referenced metapopulation approach that considers 3,362 subpopulations in 220 countries of the world, as well as human mobility taking into account air travel flow connections and short-range commuting data.²⁴

Epidemic forecasts are complex and need to consider a series of parameters within the social context. Vespignani and colleagues explain, "GLEAM uses real-world data covering the distribution of the worldwide population, their interactions and journeys, and the spatial structure and volumes of national and international air traffic. By combining these datasets with realistic models of infection dynamics, GLEAM can deliver forecasts for the spreading pattern of infectious diseases epidemics. We have thoroughly tested and validated GLEAM against historical epidemic outbreaks including the 2002/03 SARS epidemic. In 2009, GLEAM has been used to produce real-time forecasts of the unfolding of the H1N1 pandemic."²⁵

GLEAMviz offers three types of visualization:

- A 2-D map depicting the spread of the infection with charts showing the number of new cases at various levels of detail.
- A 3-D globe with a concise overview of the spread.
- Geographic and concentric views by SPaTO visual explorer depicting how the structure of the airport network influences the notion of distance. The outputs remap all the transportation hubs according to the time it takes for the infection to reach them from the moment of outbreak.

GLEAMviz, which is publicly available for download, allows setting up and executing simulations, and retrieving and visualizing the results. It was developed by an international team lead by Alessandro Vespignani (team coordinator) and Vitoria Colizza. It is hosted at three institutions: College of Computer and Information Sciences and Department of Health Sciences, Northeastern University, Boston, MA, USA; Complex Networks & Systems Group, ISI Foundation, Turin, Italy; and INSERM, Unite Mixte de Recherche 707 Paris, France.

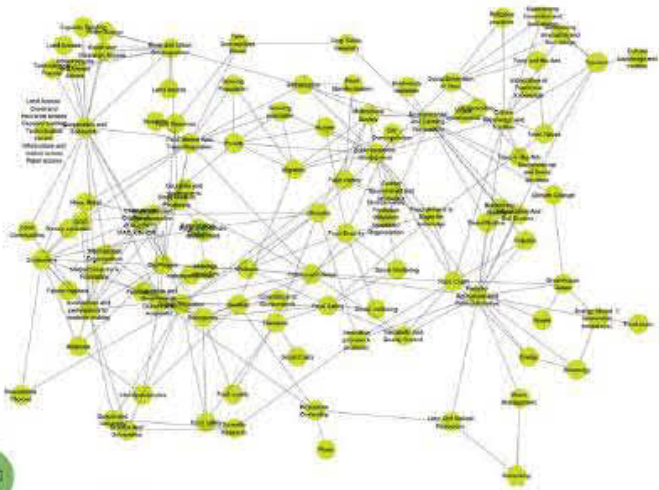


COMMUNITY STRUCTURE

Universal Exposition, Milan, 2015

THE NETWORK

The first step involved the identification of subthemes and the examination of interactions among them. For that, DensityDesign created a series of network diagrams that started with hand sketches and ended with the digital version reproduced here.

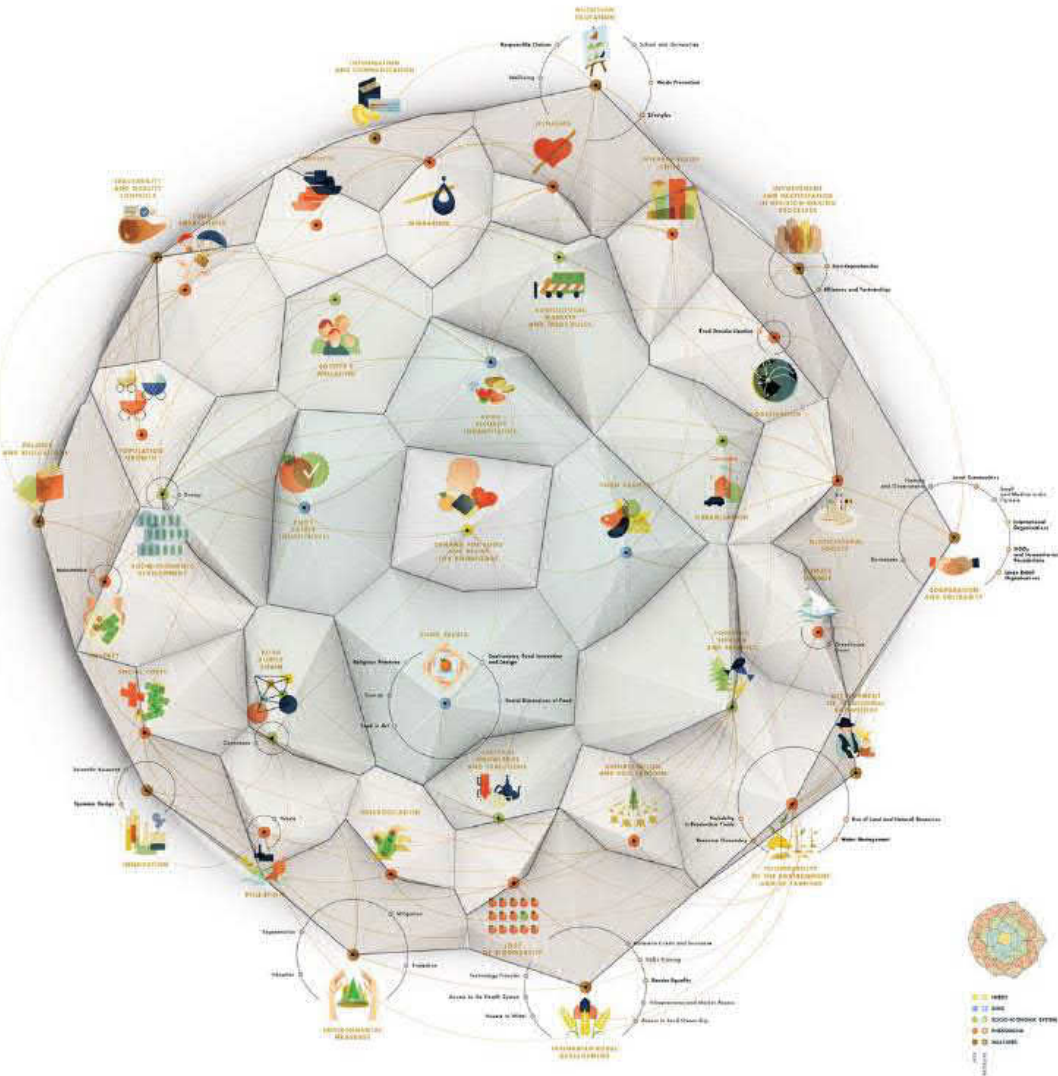
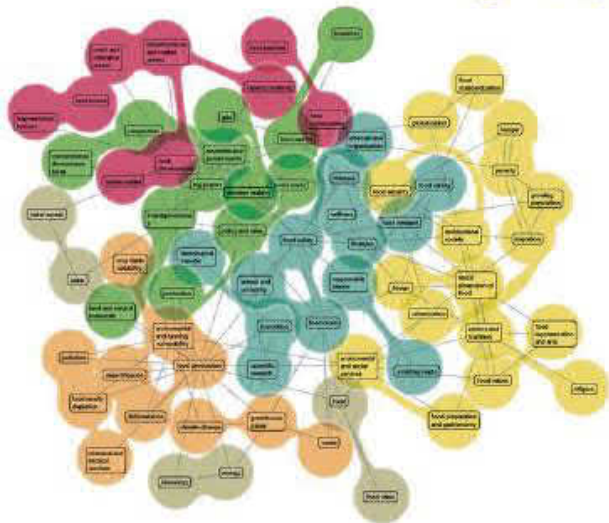


CLUSTERING

After creating the relational structure, they grouped the subthemes into five categories:

- Needs: The needs of humans to live and to meet vital needs, and our needs to know;
- Aims: The satisfaction of our needs drives humans to create products and to achieve goals;
- Socioeconomic system: The productive, social, economic environment;
- Phenomena: The main effects of human actions that all humanity faces today;
- Measures: The most significant political, scientific, technological, managerial, cultural, and educational activities that human beings can develop, with their capacity for innovation, to improve the planet for a sustainable future.

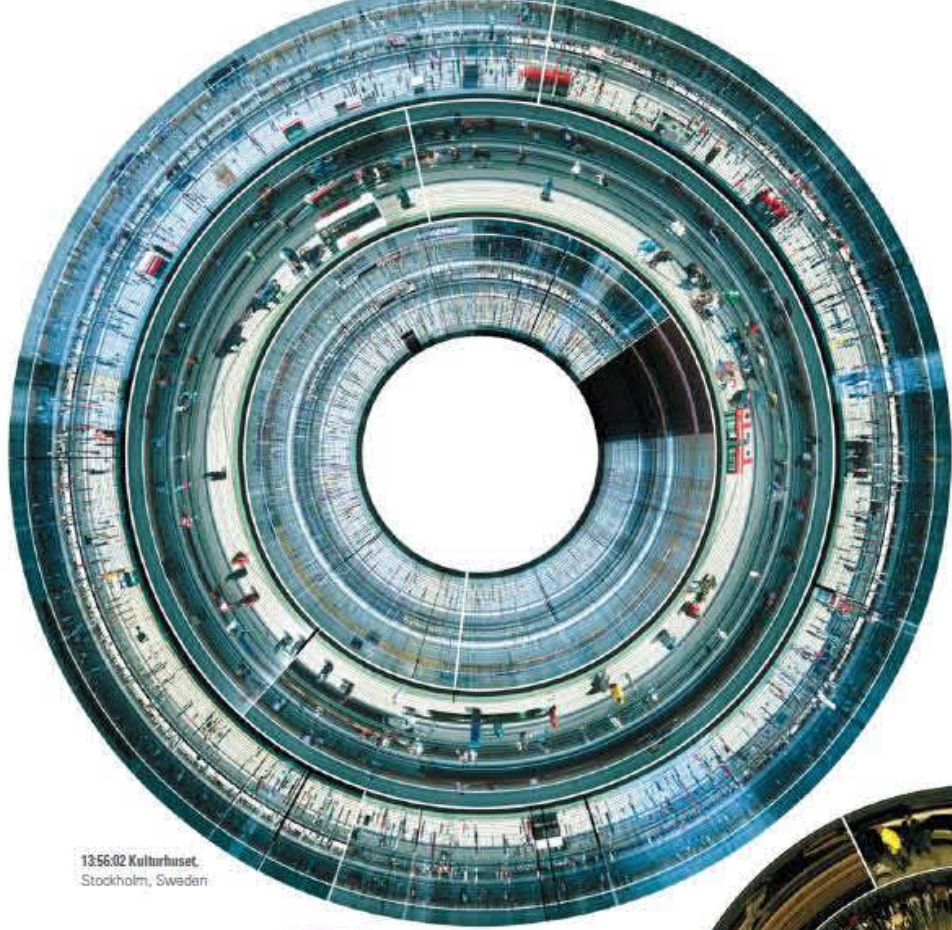
Each color stands for one of five categories structuring the subnetworks within the main theme.



estructuras temporales

flujos y líneas de tiempo

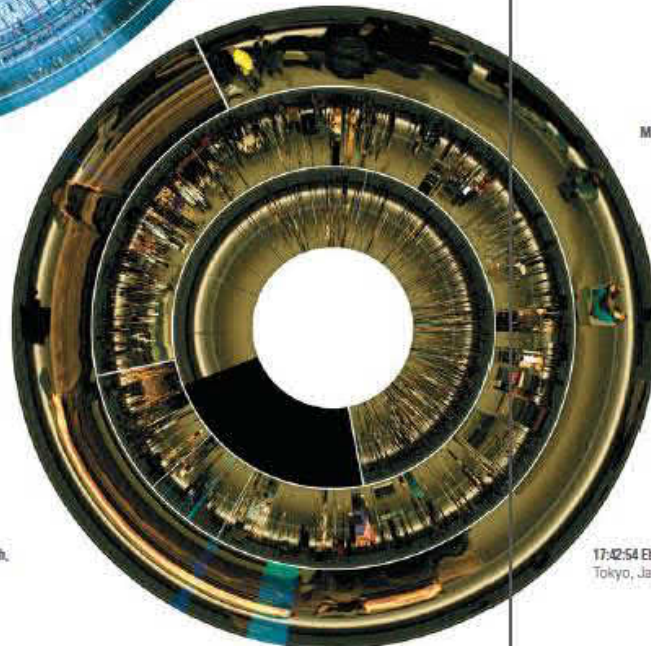
TEMPORAL STRUCTURES: TIMELINES AND FLOWS



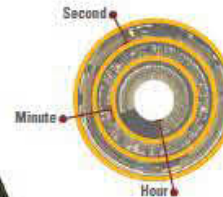
13:56:02 Kulturhuset,
Stockholm, Sweden



18:55:03 Venice Beach,
California, USA



17:42:54 Ebisu,
Tokyo, Japan



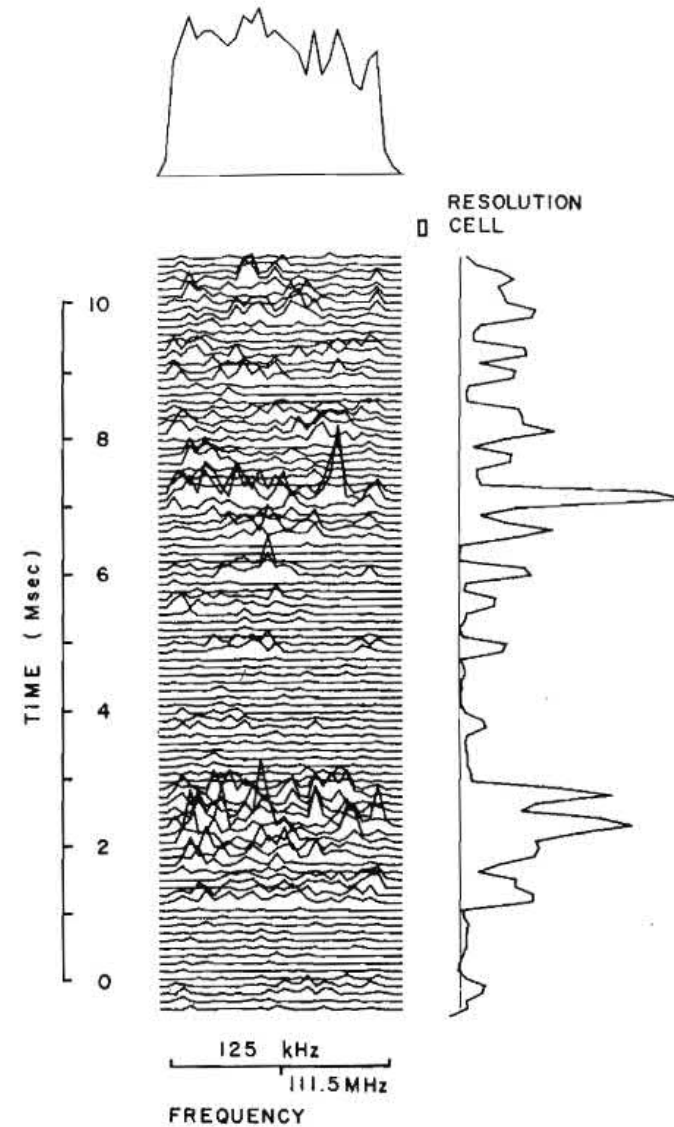
Jussi Ängeslevä and Ross Cooper, U.K.:
"Last Clock," 2002.

Similar to an analog clock, the interface has three concentric circles, each representing a measure of time, with the outermost ring standing for seconds. The interface is connected to a video source that feeds the clock at each level, so that at every second a new image is added, coinciding with the clock "hand." The video can be any source devised by the authors, including a recent application for the iPad, which allows anyone to create their clocks with personal footage (<https://itunes.apple.com/us/app/last-clock/id460584423?mt=8>).

Time is an abstract concept and, thus, not inherently visual. Much of the terminology we use for time is based on our concrete experience of space and of the physical environment. In the seminal book *Metaphors We Live By*, Lakoff and Johnson explain that the expressions we use to describe temporal experiences in most idioms emerge from our concepts of "containers" and "moving objects." "The 'time is a moving object' metaphor is based on the correlation between an object moving towards us and the time it takes to get to us. The same correlation is a basis for the 'time is a container' metaphor (as in 'he did it in ten minutes'), with the bounded space traversed by the object correlated with the time the object takes to traverse it. Events and actions are correlated with bounded time spans, and this makes them 'container objects.'"

Similarly, this data-rich graphic of signals from pulsars shows both marginal distributions:

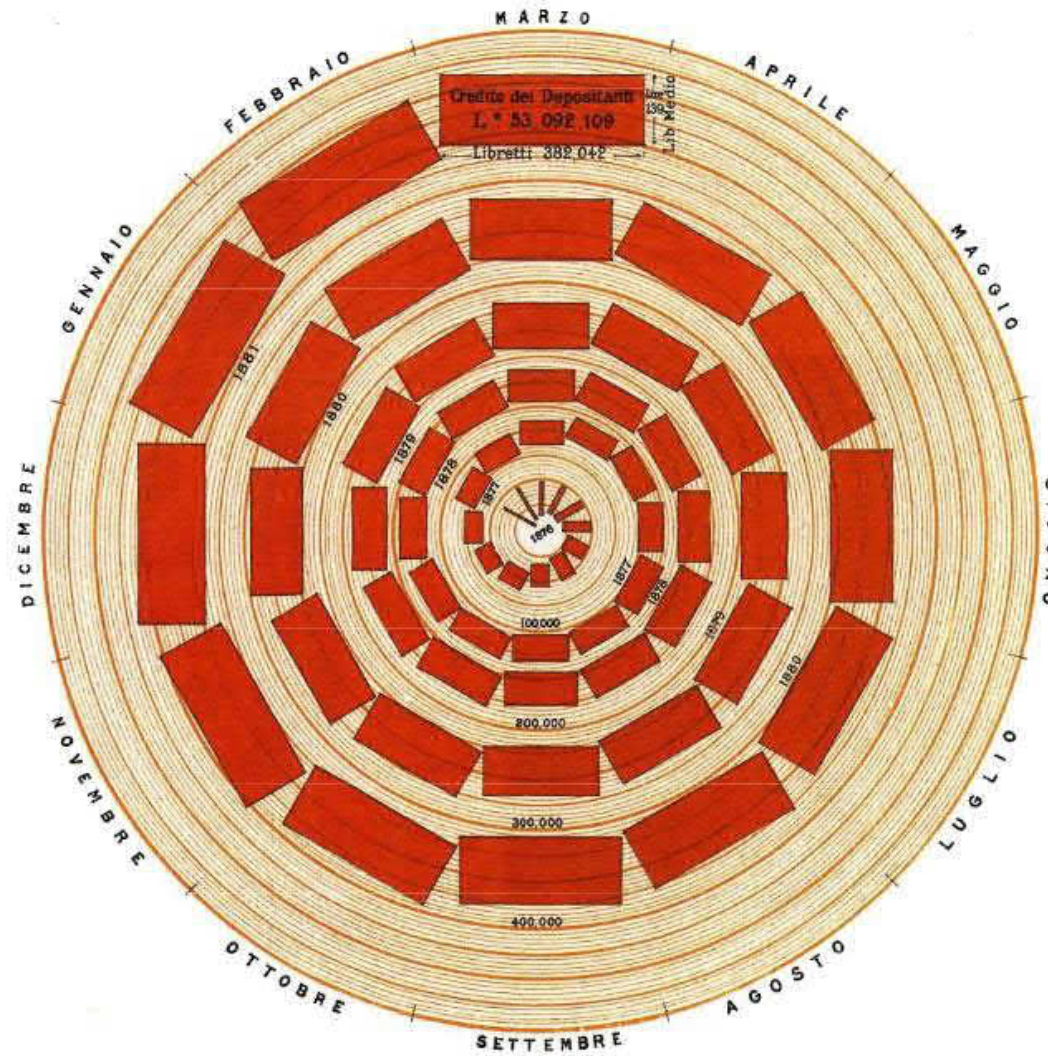
Timothy H. Hankins and Barney J. Rickett, "Pulsar Signal Processing," in Berni Alder, et al., eds., *Methods in Computational Physics, Volume 14: Radio Astronomy* (New York, 1975), p. 108.



Narrowband spectra of individual subpulses. Each point of the intensity $I_q(t)$ plotted on the right is the sum of the distribution of intensities across the receiver bandwidth shown in the center. At the top is plotted the spectrum averaged over the pulse. In the limit of many thousands of pulses this would show the receiver bandpass shape.

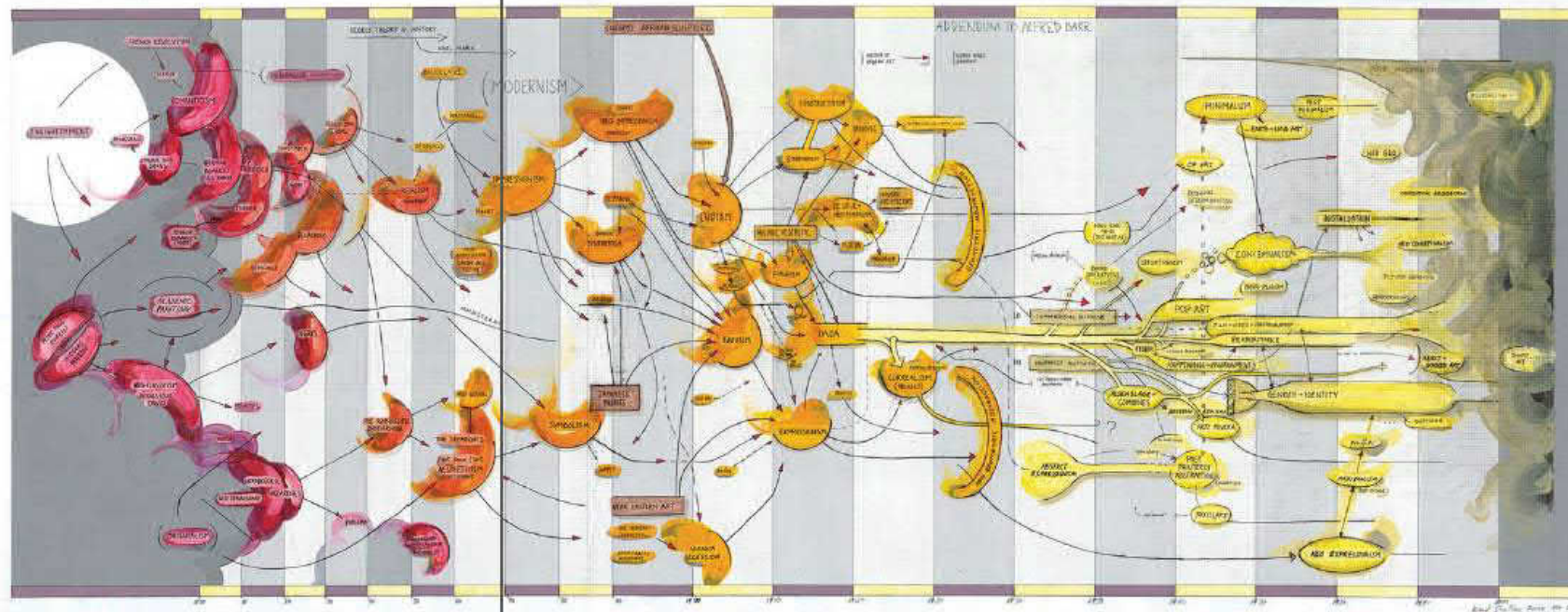
CASSE POSTALI DI RISPARMIO ITALIANE

Numero dei Libretti, Libretto medio e Deposito totale
al fine di ogni mese



This multivariate history of the Italian post office uses two dimensions in a way nearly consistent with this principle, with the number of postal savings books issued and the average size of deposits multiplying up to total deposits at the end of each month from 1876 to 1881.

Antonio Gabaglio, *Teoria Generale della Statistica* (Milan, second edition, 1888).



SKETCH OF ALFRED BARR'S DIAGRAM "CUBISM AND ABSTRACT ART", 1955

The diagram illustrates the evolution of modern art movements from 1880 to 1955. Key movements and their relationships are shown:

- 1880:** JAPANESE PRINTS (red box), IMPRESSIONISM, SYNTHETISM, NEO-IMPRESSIONISM.
- 1890:** CUBISM (influenced by Synthetism and Neo-Impressionism).
- 1900:** PURE CUBISM (red box), FAUVISM, EXPRESSIONISM, FUTURISM, DADAISM, SURREALISM.
- 1905:** MODERN SCULPTURE (red box), CUBISM.
- 1910:** MODERN AESTHETIC (red box), CUBISM, SUPREMATISM, CONSTRUCTIVISM.
- 1915:** DE STIJL and NEOPLASTICISM, BAUHAUS.
- 1920:** MODERN ARCHITECTURE (red box), CONSTRUCTIVISM, BAUHAUS.
- 1925:** NON-GEOMETRICAL ABSTRACT ART, GEOMETRICAL ABSTRACT ART.

Arrows indicate the flow and influence between these movements over time.

Ward Shelley created "Addendum to Alfred Barr, ver. 2" in 2007, which extends Barr's original diagram, positioning it at the center and depicting both past and future events around it. The chart starts with the Enlightenment and the rivalry between painters Peter Paul Rubens and Nicolas Poussin, and ends in 2000. The diagram keeps the original diagrammatic vocabulary of using arrows to show direction of influence. The three colors stand for separating the three components of the graph and separating before and after the original Barr diagram. Time is well demarcated on the top and bottom of the work, which is reinforced by the gray bands.

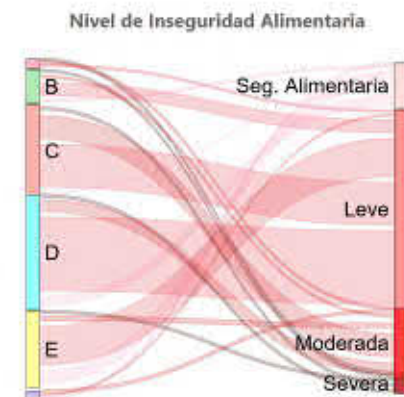
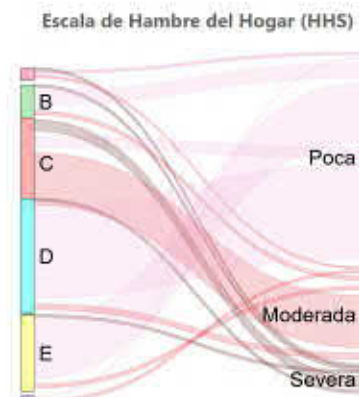
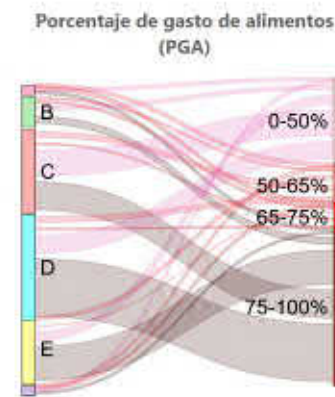
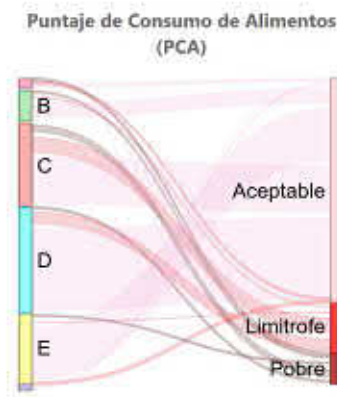
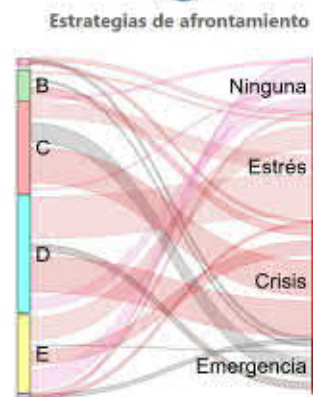
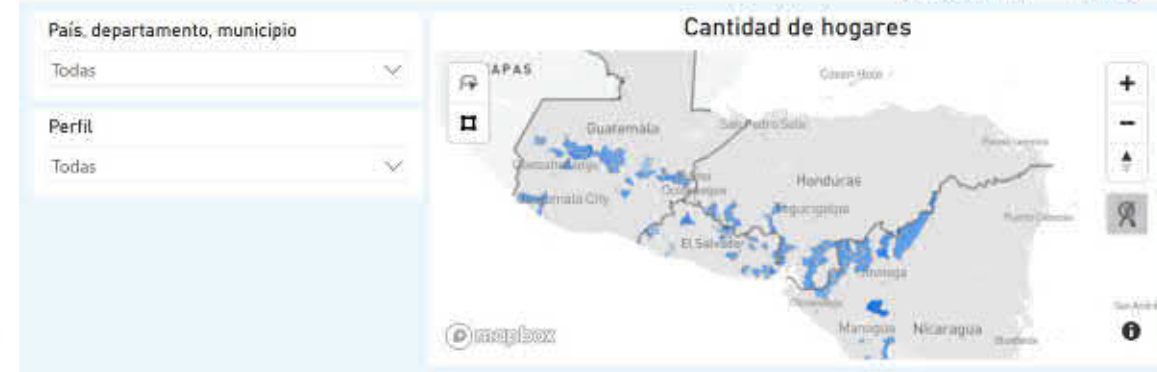
In describing this work, Shelley writes, "I like to present narratives with sprawling information-rich panoramas. Yet these diagrams are radical reductions of written sources I've researched... I have had to choose who and what to include, who and what not. Because the variables that I have to work with are extremely limited, the people and events I use are reduced to symbols that are plotted in relationship to each other... in diagrams. Even within such limitations, it is possible to tell a compelling story."⁴²

98 DESIGNER INFORMATION



Análisis de perfiles de hogar del proyecto: Central America Multi-Hazard Early Warning

Evolución de variables principales - Metas SAN - Levantamiento 1 (Agosto 2020)



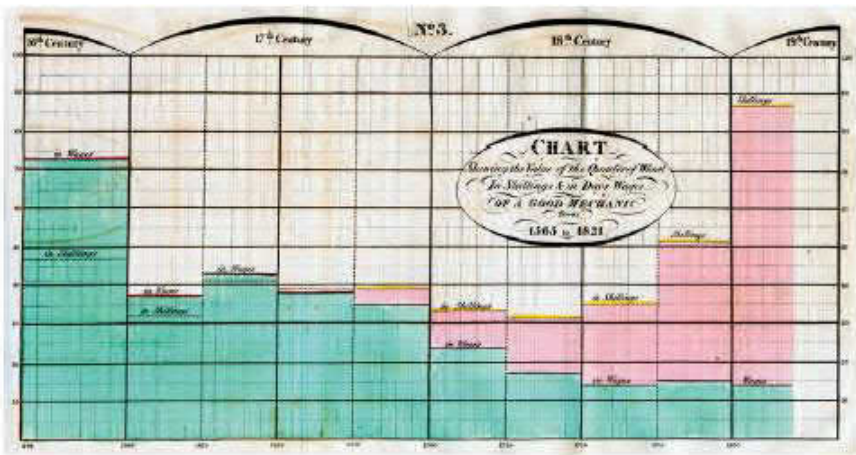
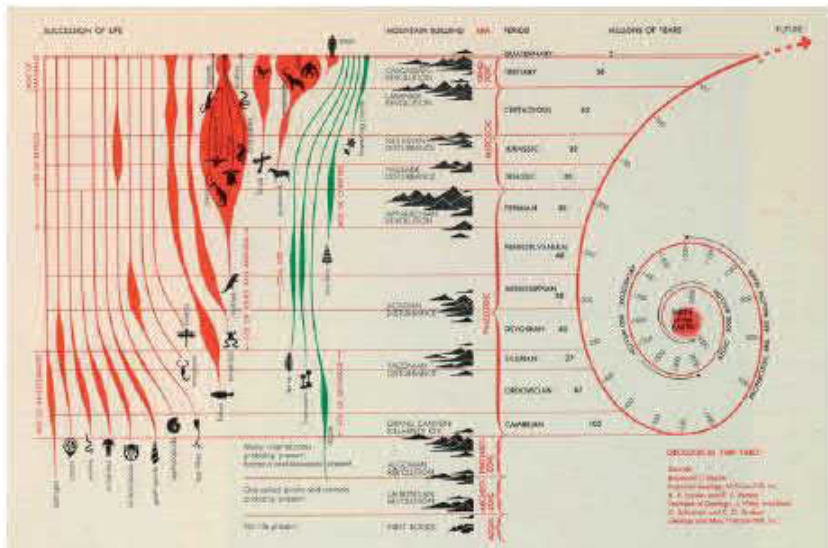
GIS4tech (2022) Herramienta para el análisis de perfiles con Inteligencia Artificial “DATAface”.

Análisis de perfiles de hogar del proyecto
“Central America Multi-Hazard Early Warning”

“DATAface,” an AI-powered profile analysis tool. Analysis of household profiles for the “Central America Multi-Hazard Early Warning” project
<https://bi.gis4tech.com/CAMHEW>

Herbert Bayer, U.S.: "Diagram of the Chronology of Life and Geology," 1953.

The "Diagram of the Chronology of Life and Geology" appeared in the spectacular *World Geo-Graphic Atlas* designed by well-known designer Herbert Bayer and published by the Container Corporation of America in 1953. It tells the story of geology and life on Earth as a function of time. On the right-hand side, the spiral represents time. Time is portrayed backward, with the starting point (or the end of data in the diagram) at the top right, when human life starts, closer to the label "future." It regresses to the beginning of our planet, millions of years back. The choice of the spiral is not arbitrary; rather, it enables, on one hand, the representation of such a huge span of time and, on the other, focus on the period when life occurs. The scale of time is in millions of years, with numbers positioned along the timeline. Horizontal lines connect specific times in the spiral with the whole diagram. The lines mark the different phases of the Earth's history. Each phase is labeled and presents numerical information about its duration (also in millions of years). Phases are grouped into Eras, labeled in red. From right to left, the diagram displays the chronology of geological formations (mountains in black), plant life (green vertical lines), and animal life (red vertical lines). Each categorical group is represented graphically (pictograms) and verbally. Line variations represent quantitative information about each species, including those that went extinct.

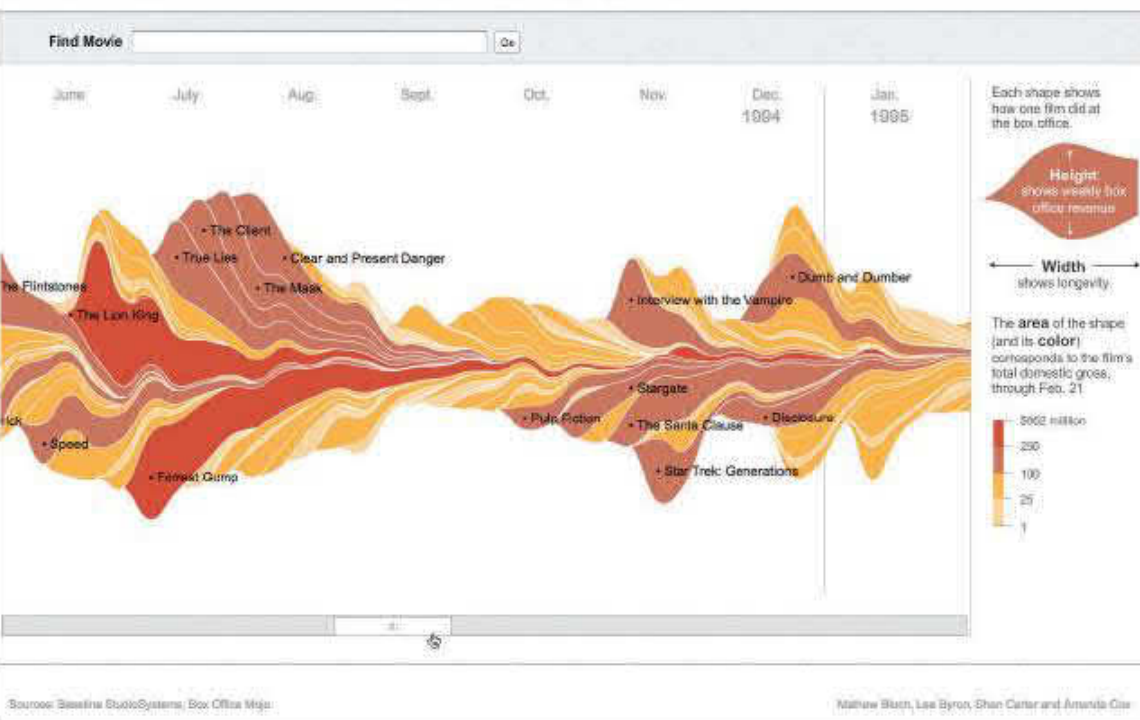


William Playfair created the "Chart Shewing the Value of the Quarter of Wheat in Shillings & in Days Wages of a Good Mechanic from 1565 to 1821" with the purpose to compare wages against the cost of wheat. It was published in *A Letter on Our Agricultural Distresses, Their Causes and Remedies: Accompanied with Tables and Copper-plate Charts, Shewing and Comparing the Prices of Wheat, Bread, and Labour, from 1565 to 1821*.

February 23, 2008

The Ebb and Flow of Movies: Box Office Receipts 1986 — 2008

Summer blockbusters and holiday hits make up the bulk of box office revenue each year, while contenders for the Oscars tend to attract smaller audiences that build over time. Here's a look at how movies have fared at the box office, after adjusting for inflation.



Matthew Bloch, Lee Byron, Shan Carter, and Amanda Cox (New York Times), U.S.: "The Ebb and Flow of Movies: Box Office Receipts 1986–2008," 2008.

The visualization depicts box office revenues for 7,500 movies over twenty-one years. The "Ebb and Flow of Movies: Box Office Receipts 1986–2008" was published in February 2008 by the *New York Times* both on the printed version and online. It was designed by Matthew Bloch, Lee Byron, Shan Carter, and Amanda Cox. The visualization uses the *Streamgraph* method devised by Lee Byron, which arranges the layers in an organic stacked form. The method was inspired by *ThemeRiver*, a method devised by Havre and colleagues in 2000, a technique that creates a smooth interpolation from discrete data and generates a symmetrical layout of the layers centered around the horizontal axis, rather than stacked in one direction.⁴¹

Streamgraph also borrowed techniques from *NameVoyager* by Wattenberg, described on the previous page.

The graph reproduced here depicts the dichotomy between box office hits and Oscar nominations that was discussed in the original article. Time is represented horizontally from left to right. The height of each band of film represents the box office revenue per week, and the width its longevity. The area of the shape corresponds to the film's total domestic gross through February 21, 2008. The same is true of color, which has a four-color palette that ranges from pale yellow (low gross) to saturated orange (high gross).

Stacked graphs in general involve trade-offs, because the heights of individual layers add up to the overall height of the graph. With the purpose to spotlight stacked graphs as an interesting object of study, Byron and Wattenberg discuss several issues with the legibility of stacked area graphs with a fixed and varying baseline in the informative paper "Stacked Graphs—Geometry & Aesthetics."⁴²

www.nytimes.com/interactive/2008/02/23/movies/20080223_REVENUE_GRAPHIC.html

SPATIAL STRUCTURES: MAPS

Fernanda Viêgas and Martin Wattenberg, U.S.:
"Wind Map," 2012.

The 2012 "Wind Map" is a personal art project by Fernanda Viêgas and Martin Wattenberg devised to visualize the wind as a source of energy. The project shows wind forces over the United States using data from the National Digital Forecast Database and is revised hourly. The varying weights of lines represent the velocity of the wind flows. The screenshot depicts a "living portrait" at a given date. Patterns are easily distinguished given the orientation and thickness of lines, which ultimately reveal the hidden geography.

<http://hint.fm/wind>

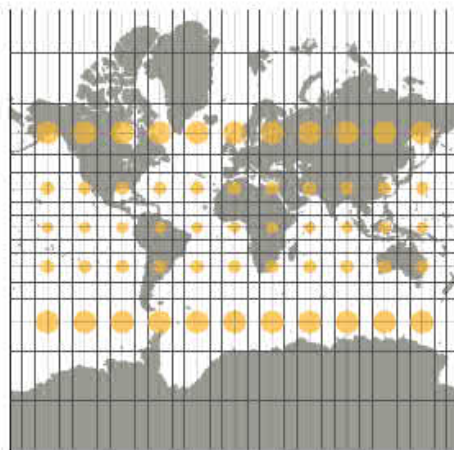
We encounter the term **map**, as well as the act of **mapping** in diverse fields of knowledge, all, however, with the shared characteristic of being "a diagram or collection of data showing the **spatial distribution** of something or the **relative positions** of its components."¹ The oldest (c. 1527), and perhaps the most frequent, use of the term *map* refers to representations of geographical data, ranging from the Earth's surface to parts of it.² Maps are used in other disciplines, such as genetics, in diagrammatic representations of the order and distance of the genes (see page 53), and in mathematics, as correspondences between two or more sets of elements. These are just two fields in which maps are frequently used.

PROJECTIONS

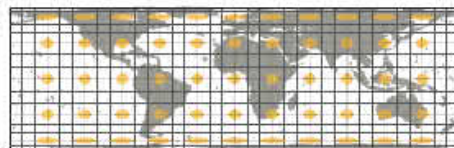
Robinson and colleagues warn, "There is no such thing as a bad projection—there are only good and poor choices."²² All map projections result in distortions of one or more of the geometric properties of angles, areas, shapes, distances, and directions. As illustrated on the right, some projections preserve areas but not local angles; all projections distort large shapes, some more than others; all projections distort some distances; and so on. Distortions should be taken into consideration when selecting the projection that best fits the purpose of the map.

The maps on this page use Tissot's *indicatrix*, a graphic device that illustrates distortion when circles change into ellipses. Changes in geometry indicate the amount of angular and/or areal distortion at any particular location in the map. The device was devised by French mathematician Nicolas Auguste Tissot in 1859.

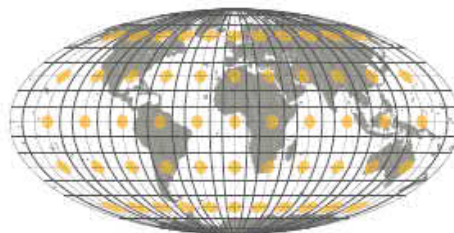
The **Mercator projection** is conformal. Areas and shapes vary with latitude, especially away from the Equator, reaching extreme distortions in the polar regions. All indicatrices are circles as there are no angular distortion.



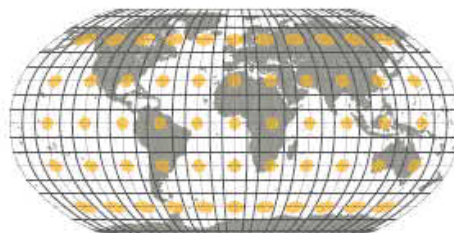
The **equal-area cylindrical projection** preserves area. Shapes are distorted from north to south in middle latitudes and from east to west in extreme latitudes.



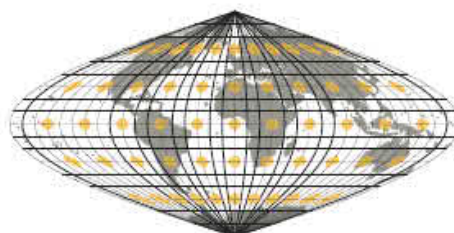
In the **Mollweide projection**, shapes decrease in the north-south scale in the high latitudes and increase in the low latitudes, with the opposite happening in the east-west direction.



In the **Robinson projection**, all points have some level of shape and area distortion. Both properties are nearly right in middle latitudes.

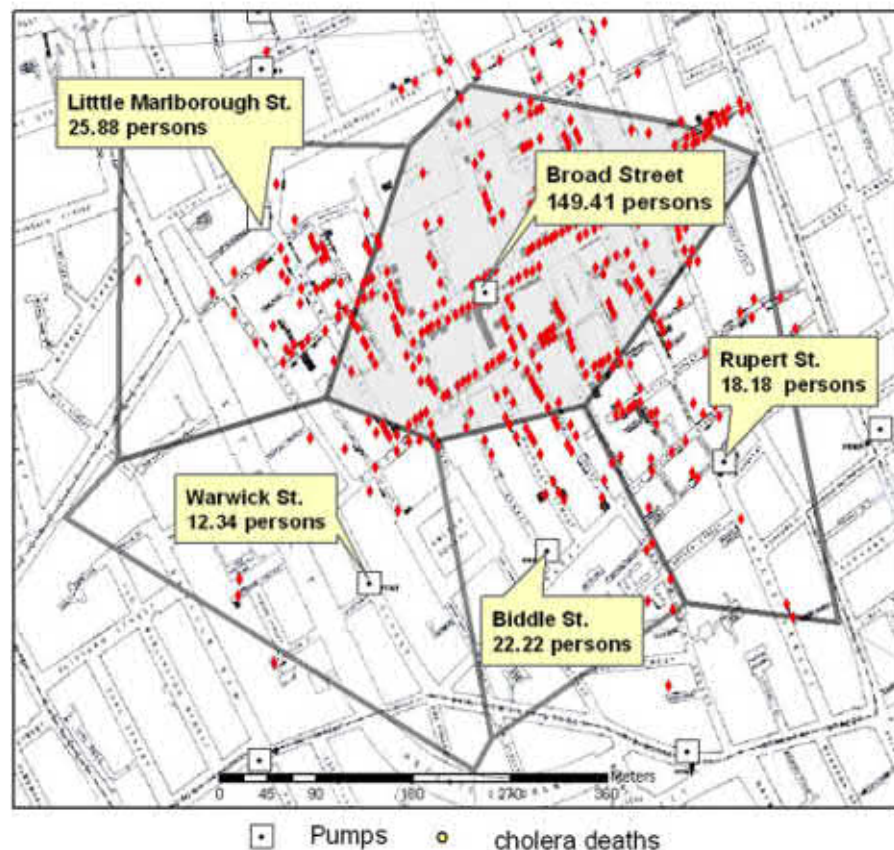


The **sinusoidal projection** preserves area, such that areas on the map are proportional to same areas on the Earth. Shapes are obliquely distorted away from the central meridian and near the poles.

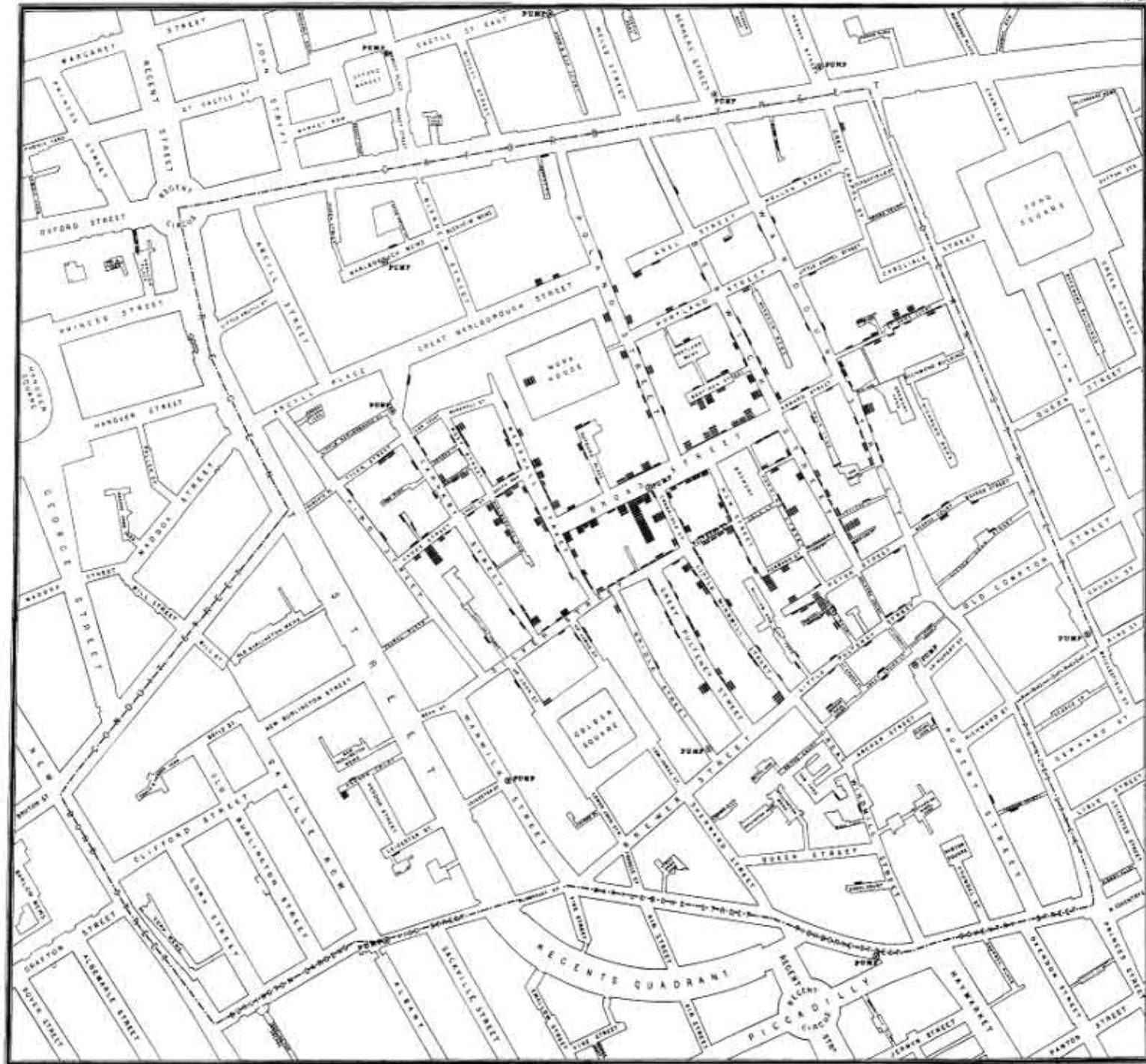


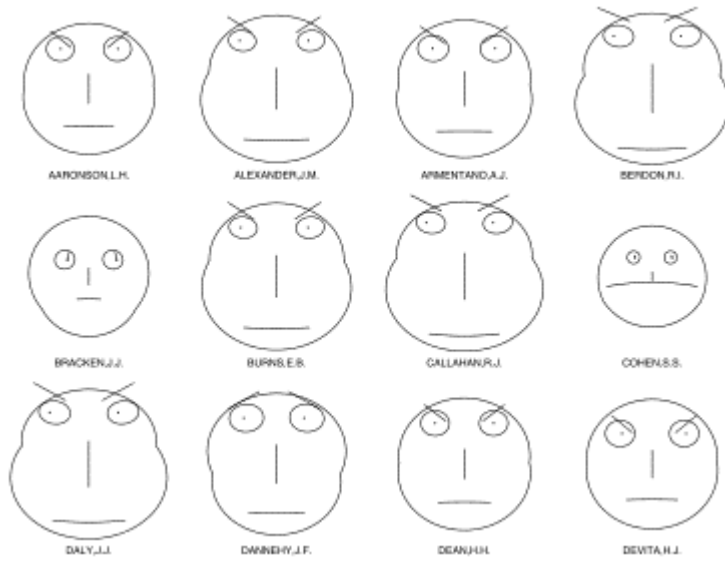
1854. Dr. John Snow
Mapa de Cólera de Londres.
[Map of Cholera in London.](#)

Remaking Snow's 1855 Map Cholera Mortality per 1,000 persons



Cholera Mortality per 1,00 persons for central pump catchments.



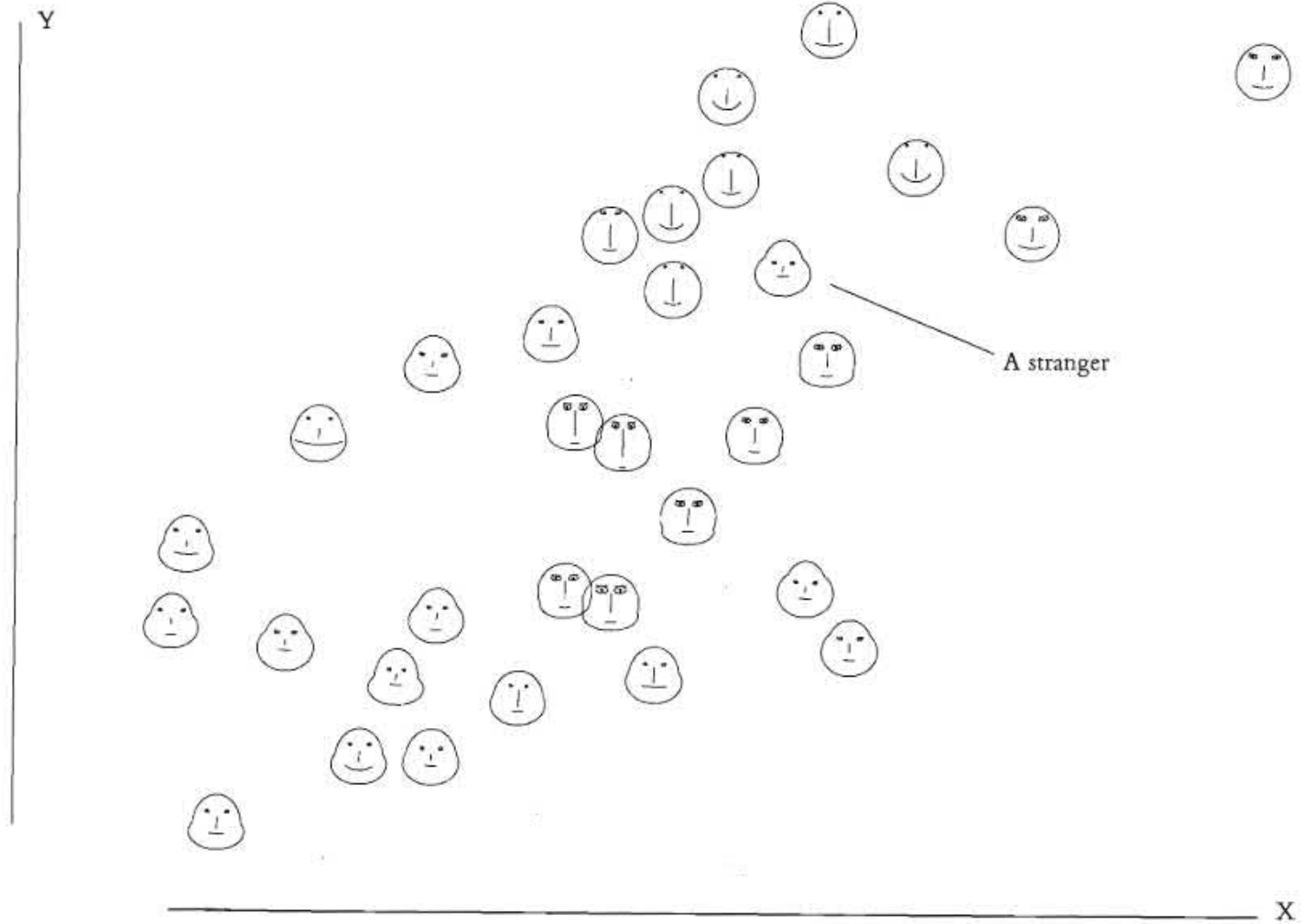


Caras de Chernoff para evaluaciones de los juzgados de US.

Chernoff faces for evaluations of U.S. courts.

Encoding of data measures can be far more elaborate. The plotted points here are Chernoff faces, which reduce well, maintaining legibility even with individual areas of .05 square inches as shown.³ The analyst would observe the standard X-Y scatterplot and then turn to the within-scatter detail, seeking clusters of similar observations over the X-Y plane. Outlying faces and those inconsistent with others in the neighborhood—they are, of course, *strangers*—should be identified by observation number or name.

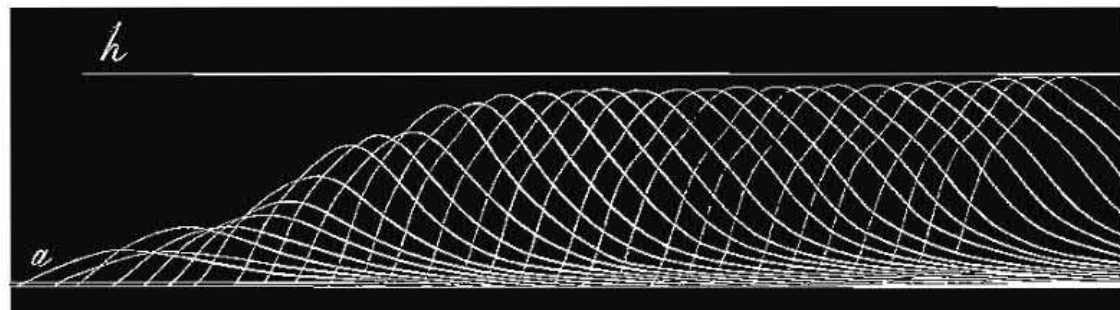
Herman Chernoff, "The Use of Faces to Represent Points in k-Dimensional Space Graphically," *Journal of the American Statistical Association* 68 (June 1973), 361–368. For an application of faces located over two dimensions, see Howard Wainer and David Thissen, "Graphical Data Analysis," *Annual Review of Psychology*, 32 (1981), 191–241.





MEDICAL monitoring technologies often produce so much data that sparkline-like graphics are essential to help identify and contextualize clinically relevant events from a torrent of numbers. Above, in this graph of brain waves, 8 tracks (with a **scale**) of an electroencephalogram begin with calm background activity and then eventually shift into polyspike bursts. At right and below, E. J. Marey, the great French pioneer in creating displays of visual evidence, shows high-resolution physiological data. Depicted are multiple time-traces of empirical measurements, as a pointer scratches data paths onto a smoked carbon plotting field.

Above, Kenneth A. Kooi, *Fundamentals of Electroencephalography* (New York, 1971), 110, redesigned. Below, E. J. Marey, *Du mouvement dans les fonctions de la vie* (Paris, 1868), 118.



Secousses provoquées par des excitations électriques d'intensité croissante : *a*, origine des secousses; *h*, parallèle à l'abscisse servant à apprécier les changements d'amplitude des secousses.





San Francisco
Emotion Map
by Christian Nold

Christian Nold's map is a visual representation of emotional data collected from participants in a workshop. The map shows the city's street grid with red dots of varying sizes and colors (red, orange, yellow) indicating emotional data points. A legend in the top left shows a color scale from red to yellow. A north arrow is also present. The map is labeled with street names like 17TH ST, 18TH ST, 19TH ST, 20TH ST, 21ST ST, 22ND ST, 23RD ST, 24TH ST, 25TH ST, and landmarks like GOLDEN GATE PARK, SERRA PARK, and SERRA HEIGHTS.



The Bio Mapping device: GPS - left, fingerclip - top and data logger on the right.



Two participants from an early Bio Mapping workshop and exhibition, at the Angel Row Gallery in Nottingham in 2005.

San Francisco Emotion Map
Nold, C. (2009). *Emotional Cartography*.
Retrieved from <http://www.emotionalcartography.net>

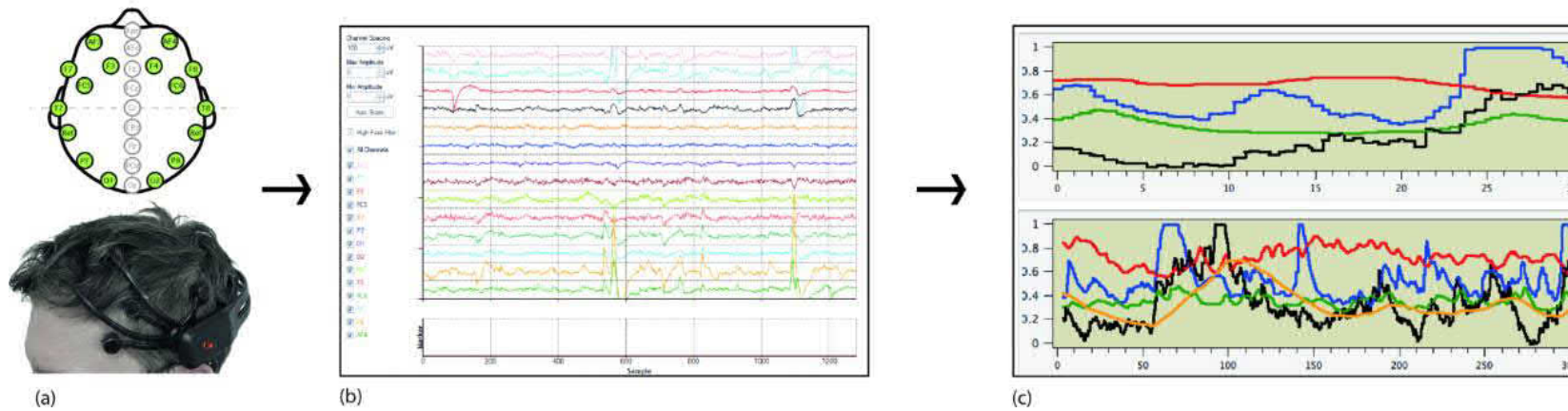


Figure 1 (A) Neural cap; (B) output from the Emotiv Testbench software: Emotiv EPOC records electroencephalography (EEG) signals from 14 sensor positions according to the 10–20 International System. Raw EEG signals are then 'translated' and classified in different emotional states and (C) output from the Emotiv Control Panel and 'Affectiv suite' (EEG data belong to the authors).

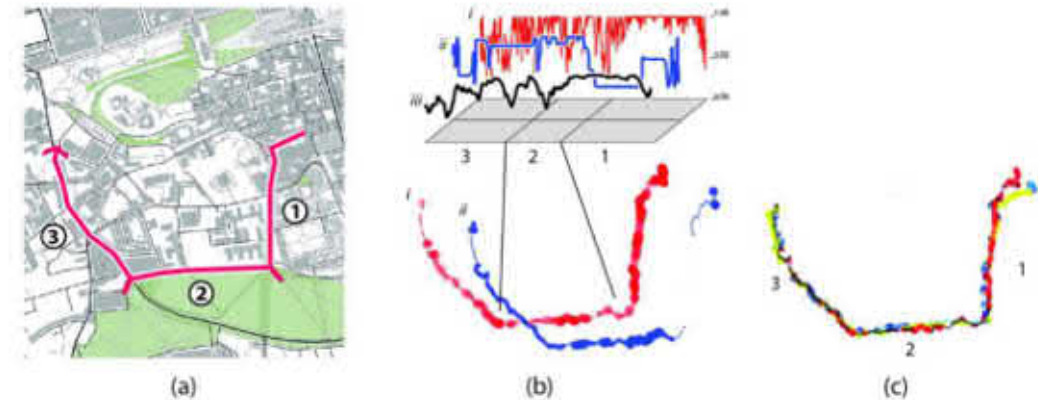
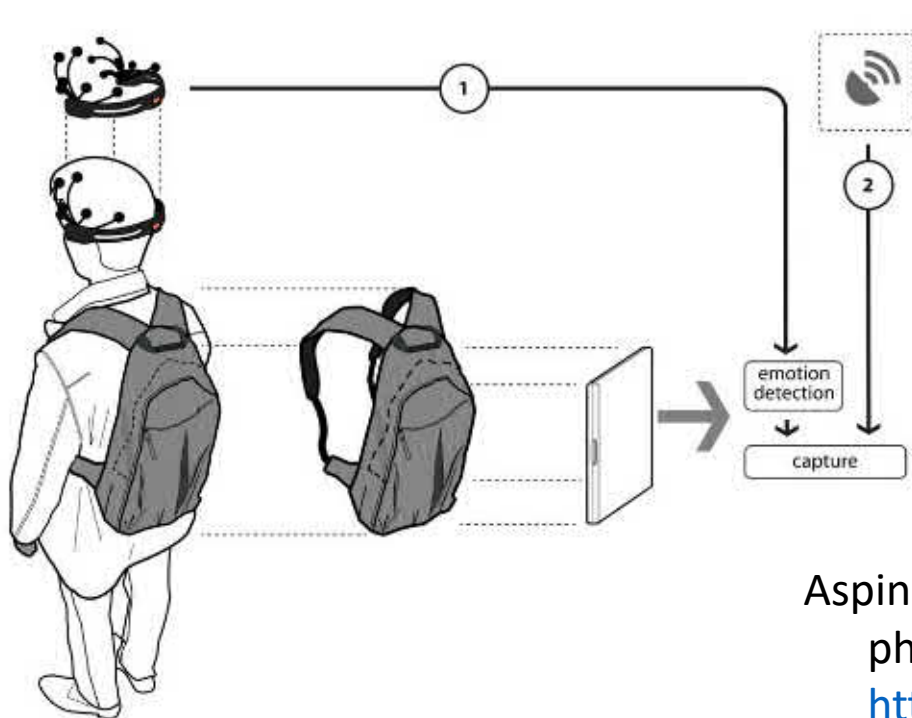
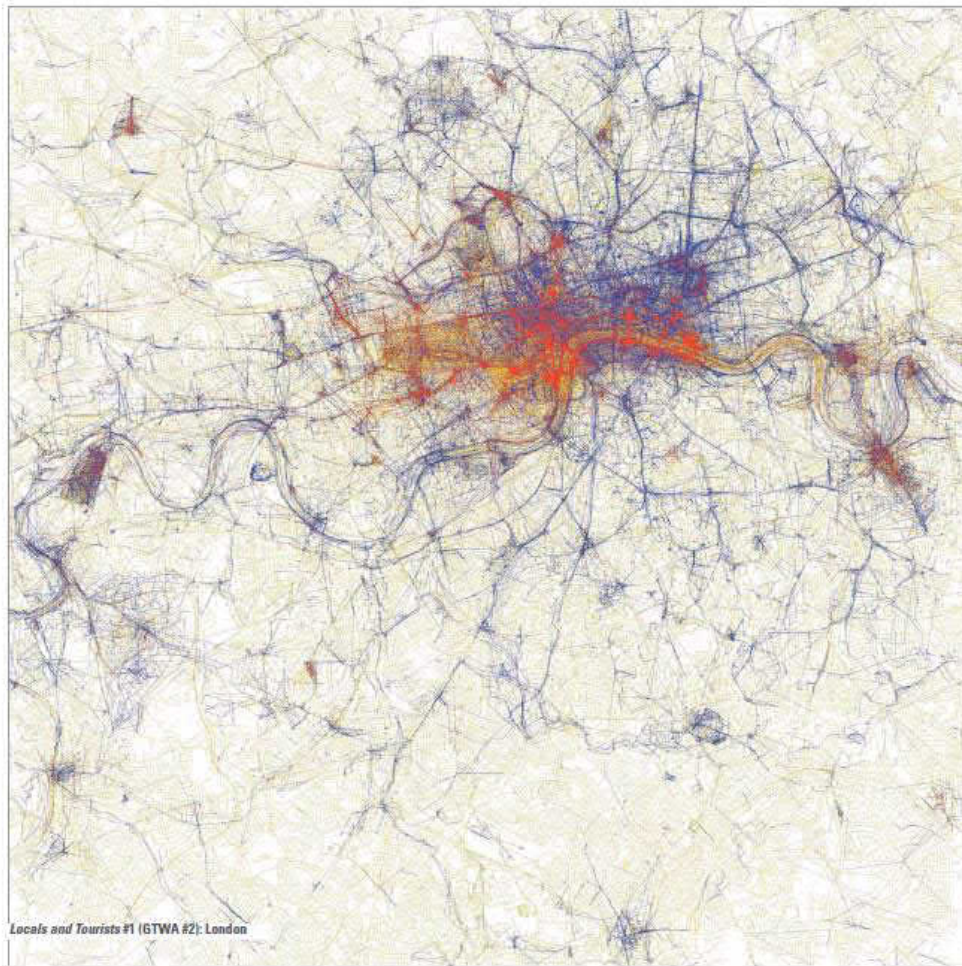


Figure 4 (A) Map of the route in central Edinburgh. (B) Emotional activity of one participant during the route, in charts (top of chart) and plot in space (bottom of chart). Red shows excitement; blue shows frustration. (C) Shows aggregate of excitement levels from the three participants. Peaks are in red, blue and yellow, respectively, for each participant.

Aspinall, P., Mavros, P., Coyne, R., & Roe, J. (2015). The urban brain: analysing outdoor physical activity with mobile EEG. *British journal of sports medicine*, 49(4), 272-276. <http://dx.doi.org/10.1136/bjsports-2012-091877>



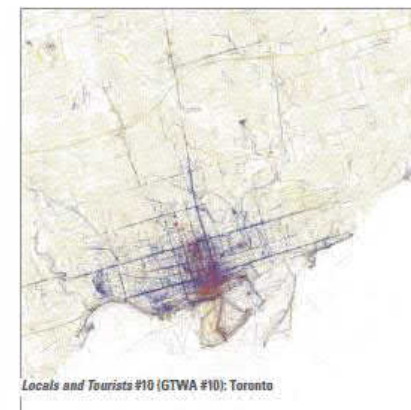
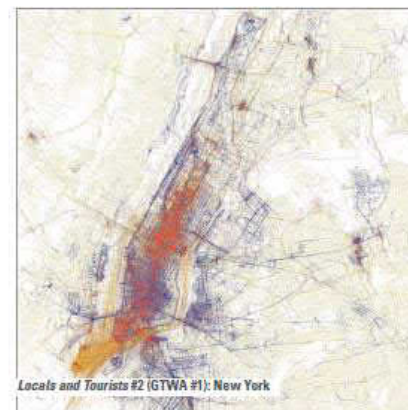
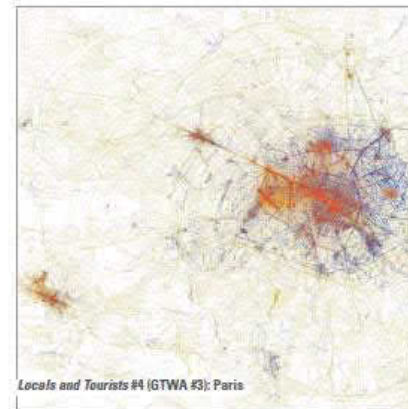
Eric Fischer, U.S.: "Locals and Tourists," 2010.

Eric Fischer created this set of thematic maps "Locals and Tourists" in 2010. The dots depict the location of photos that were geo-tagged and uploaded to the photo server Flickr. By analyzing the frequency of photos taken in the locations, Fischer was able to categorize photographers into three groups according to the criteria and color code as follows:

- Local photographers (blue dots): Locals are those who have taken pictures in this city over a range of a month or more.

- Tourists (red dots): Tourists are defined by two criteria: those who took pictures in this city for less than a month but also seem to be a local of a different city, provided by the number of photos there.
- Undefined (yellow dots): Undefined stands for images for which it was not possible to determine whether or not the photographer was a tourist, because pictures were not taken anywhere else for over a month.

www.flickr.com/photos/walkingsf/sets/72157624200158632



In Meirelles, I. (2013). *Design for Information* (Vol. 5).

<http://doi.org/10.1017/CBO9781107415324.004>

DOT DISTRIBUTION MAPS

Dot distribution maps aim at revealing the spatial distribution of phenomena using the basic element of a point as the visual mark. The maps can depict two sets of discrete data: discrete phenomenon with known geo-location information, such as medical mappings, or discrete phenomena with smooth variation, like most maps depicting census data, in which symbols are distributed within the corresponding geographic area in order to portray densities (not the specific locations of the phenomena). Whole numbers, rather than derived numbers, should be used in either case to equate to the value of symbols. In the first case, a dot equates to one phenomenon, and in the latter, it corresponds to an aggregated value (e.g., one dot representing 1,000 people).

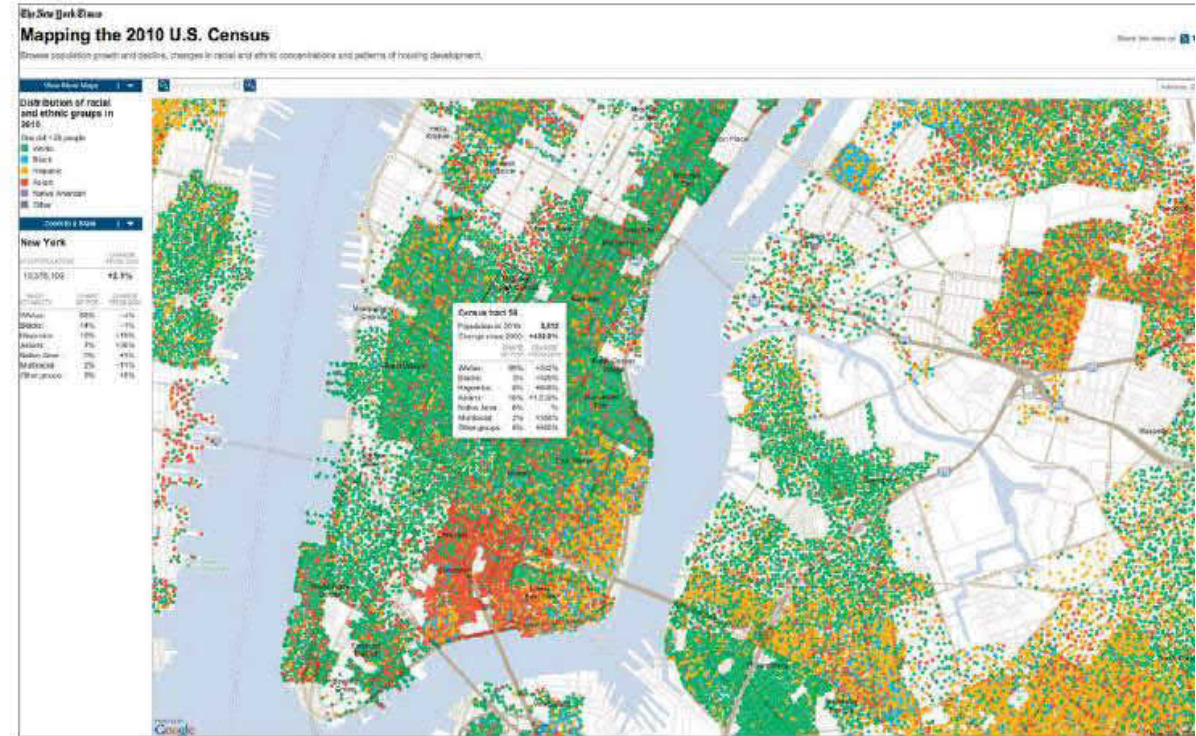
Given the current access to geo-tagged digital data, we now see a proliferation of maps with a one-to-one correspondence between datum and symbol. In these maps, dots are positioned according to a precise location (x, y-coordinates) given by the phenomenon. The maps by Eric Fischer using Flickr data are good examples.



This 1830 map by Frère de Montizon depicts population in France by administrative departments. It is the earliest known use of irregularly spaced dots as an encoding. Each dot stands for 10,000 people. The innovation of dot distribution maps went unnoticed for a while, as Robinson explains, "except for a few rather crude, large-scale applications, without clear unit values... in medical mapping, we still see that this basically simple, logical idea had to wait some thirty years to be reinvented and much longer than that to become generally known."⁴⁰

But, not all datasets contain geo-locational information for individual occurrences. Rather, most data are provided by enumeration tracts, as exemplified in the demographic map published by the *New York Times*. In these cases, three parameters should be taken into account when creating the map: the unit value, the dot size, and the dot location.

Assigning the unit value and the unit size largely affect how the map is perceived. For example, if the dot size is too small, and each unit equates to large numbers, the map might be perceived as representing phenomena that are sparser than in actuality. Similarly, if a dot size is too large, and each unit equates to small numbers, the map might give a wrong impression of high density. Problems get even harder in datasets with large density variations, for which some cartographers have used a combination of graduated and distributed dot methods. Decisions on dot placement are also not trivial and will affect perception. For manually positioning dots, it is recommended to group features according to a center of gravity within the statistical unit, as well as cross relating with other meaningful geographic information, such as topography and the location of cities. For example, in maps portraying agricultural data, it would be meaningful not to cluster symbols in urban areas. The smaller the statistical area, the easier and more meaningful the distribution of symbols will be. There are, however, a number of available programs for producing dot distribution maps, because most maps are now produced digitally.⁴¹ Also recommended is the *nomograph* developed by J. Ross Mackay as a tool to help determine the relationship between dot size and unit value.⁴²



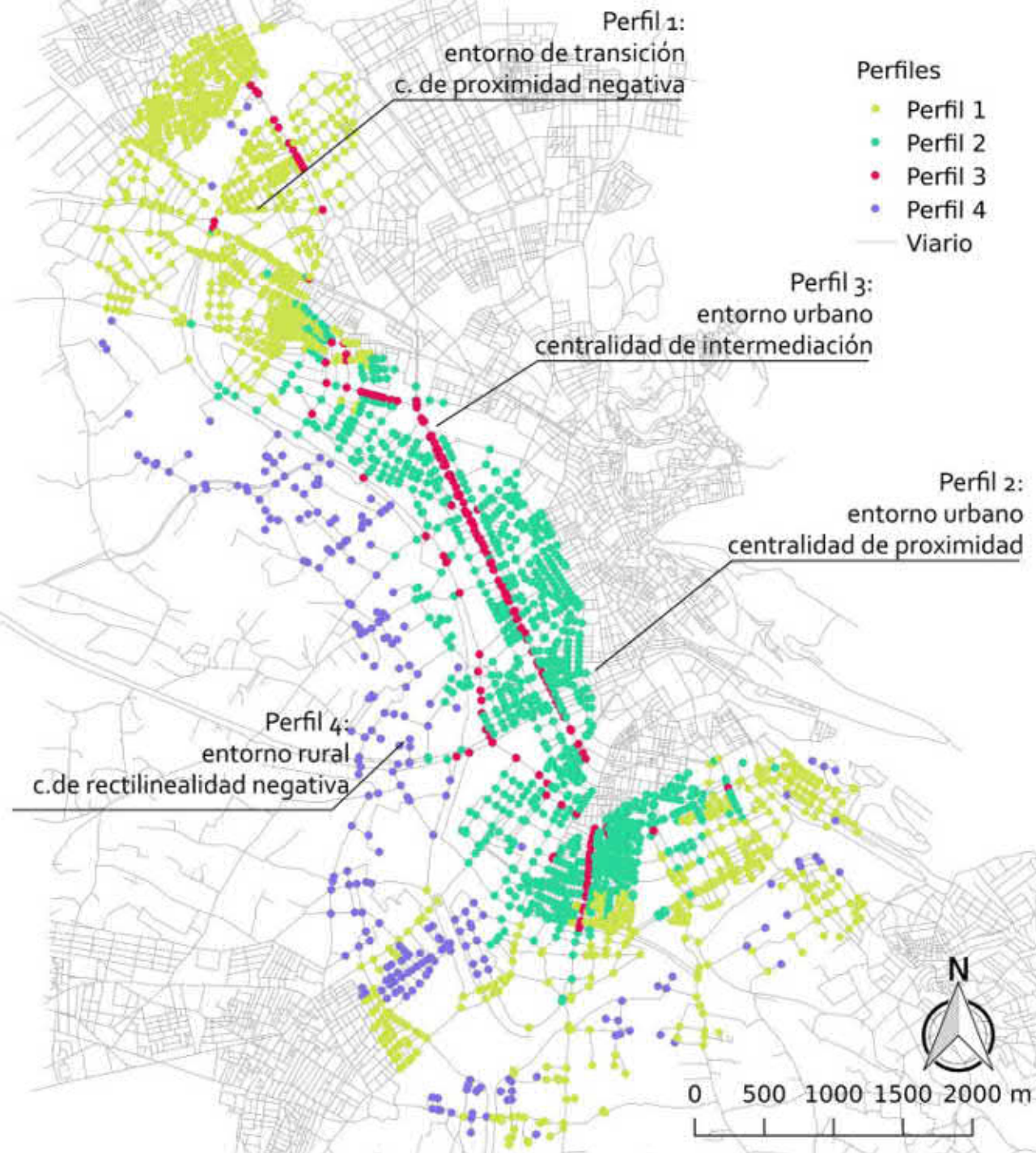
Matthew Bloch, Shan Carter, and Alan McLean
(*New York Times*). U.S.: "Mapping the 2010 U.S. Census." 2010.

The *New York Times* published an online series of interactive maps showing data from the 2010 census (Census Bureau; socialexplorer.com). The maps depict population growth and decline, changes in racial and ethnic concentrations, and patterns of housing development.

This map and the maps on the next page portray the distribution of racial and ethnic groups in the United States. The technique is dot distribution, where one dot in the map stands for twenty-five people. Dots are evenly distributed across each census tract or county. Because the map is interactive, one can look at different parts of the country and learn about their specific ethnical configurations, including trends provided by changes from the previous census in 2000.

<http://projects.nytimes.com/census/2010/map>

In Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>



Mapa Auto-organizado (SOM) de variables, con representación de perfiles

Variable	Estadísticos	Población n=2682 100.00%	Perfil 1 n=190 44.37%	Perfil 2 n=1981 39.58%	Perfil 3 n=188 6.71%	Perfil 4 n=291 8.36%	Estadísticos
Betweenness centrality	M	113932	48878	80852	889432	22546	M
	DT	238805	66413	85714	401494	49478	DT
	I		32.8	12.6	25.1	29.3	I
	sig.		***	***	***	***	sig.
	DM		49054 (-67.1)	-13360 (-28.0)	75200 (60.6)	81366 (60.2)	DM
	TE		-0.27	-0.14	0.18	-0.26	TE
Straightness centrality	M	3226.3	2232.4	2255.2	2320.8	1983.3	M
	DT	58	52	51.3	43	66.4	DT
	I		5.4	19.7	31.1	43.2	I
	sig.		***	***	***	***	sig.
	DM		8.1 (0.37)	30.9 (1.39)	80.6 (4.48)	-241 (-10.8)	DM
	TE		0.08	0.72	1.62	-2.46	TE
Closeness centrality	M	1.1E-07	9.4E-08	1.3E-07	1.3E-07	5.7E-08	M
	DT	2.07E-08	1.3E-08	1E-08	1.5E-08	1.4E-08	DT
	I		41.0	56.7	17.6	14.5	I
	sig.		***	***	***	***	sig.
	DM		-1.8E-08 (-14.47)	1.7E-08 (15.86)	2E-08 (18.12)	-1.3E-08 (-11.8)	DM
	TE		-0.22	0.86	0.16	-0.63	TE

LEYENDA

Nº Tamaño de la población
nº Tamaño de muestra
M= Media
DT= Desviación Típica
* Test de Student:

sig. Significación p-valor (nc: p<0.05)
sig. Significación p-valor (**: p<0.01)
sig. Significación p-valor (***: p<0.001)
sig. Significación p-valor (***: p<0.001)

DM= Diferencia de medias
TE= Tamaño del efecto (d de Cohen):

sig. - efecto negativo grande
sig. - efecto negativo medio
sig. - efecto negativo bajo
sig. nc: no significativo
sig. + efecto positivo bajo
sig. ++ efecto positivo medio
sig. +++ efecto positivo alto

Abarca-Alvarez, F. J., Pérez-Campaña, R. & Talavera-García, R (2017). Identificación de patrones espaciales del borde urbano mediante mapas auto-organizados de la centralidad de la red viaria. *Urbano*, 20(35), 19-29.

<http://revistas.ubiobio.cl/index.php/RU/article/view/2860>

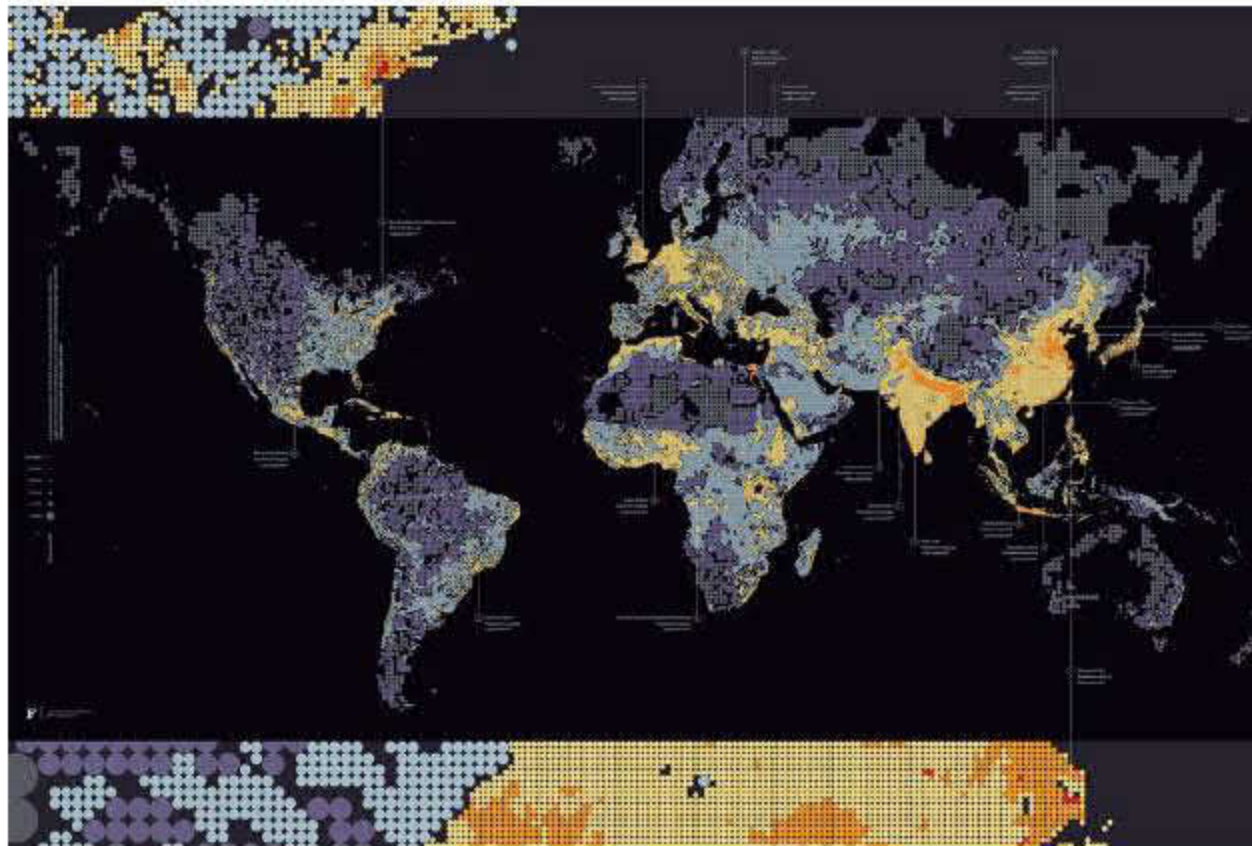
PHYSICAL

While the Internet provides the conditions for human exchange and interaction, the center of urban life is still the public space, even if it is being increasingly controlled and restricted and becoming less spontaneous and creative. During the protests, the activation of public spaces in Madrid as the headquarters of demonstrations proved to be crucial for the impact of the social movement.



1. *Pequeño apropiado* - Map of Madrid appropriated spaces by local citizens' initiatives. Research by E. Acosta, A. Balmaseda, G. Hernandez, A. Luchaga, D. Ruiz. ETSAM 2011. <http://www.fonotecol.com/?p=articulo-pequeño-apropiado-urbano>. IGC. Vivir de los espacios Urbanos. 2. *Brave people* - Map of Barcelona demonstrations in favour of people affected by housing issues. From <http://elbarcelona.files.wordpress.com>

Ecosistema Urbano. Planning for Protest
Things we could learn from #15M in Madrid



Ben Fry, U.S.: "Dencity," 2011.

In 2011, Ben Fry designed "Dencity" to show the global population density as the world reached the 7 billion milestone. Circles with varying size and hue encode population density, with larger and darker circles covering areas with fewer people. The visual encoding is effective, because the map highlights the populous areas. Fry writes, "Representing denser areas with smaller circles results in additional geographic detail where there are more people, while sparsely populated areas are more vaguely defined."⁴

In Meirelles, I. (2013). *Design for Information* (Vol. 5).

<http://doi.org/10.1017/CBO9781107415324.004>

GRADUATED SYMBOL MAPS



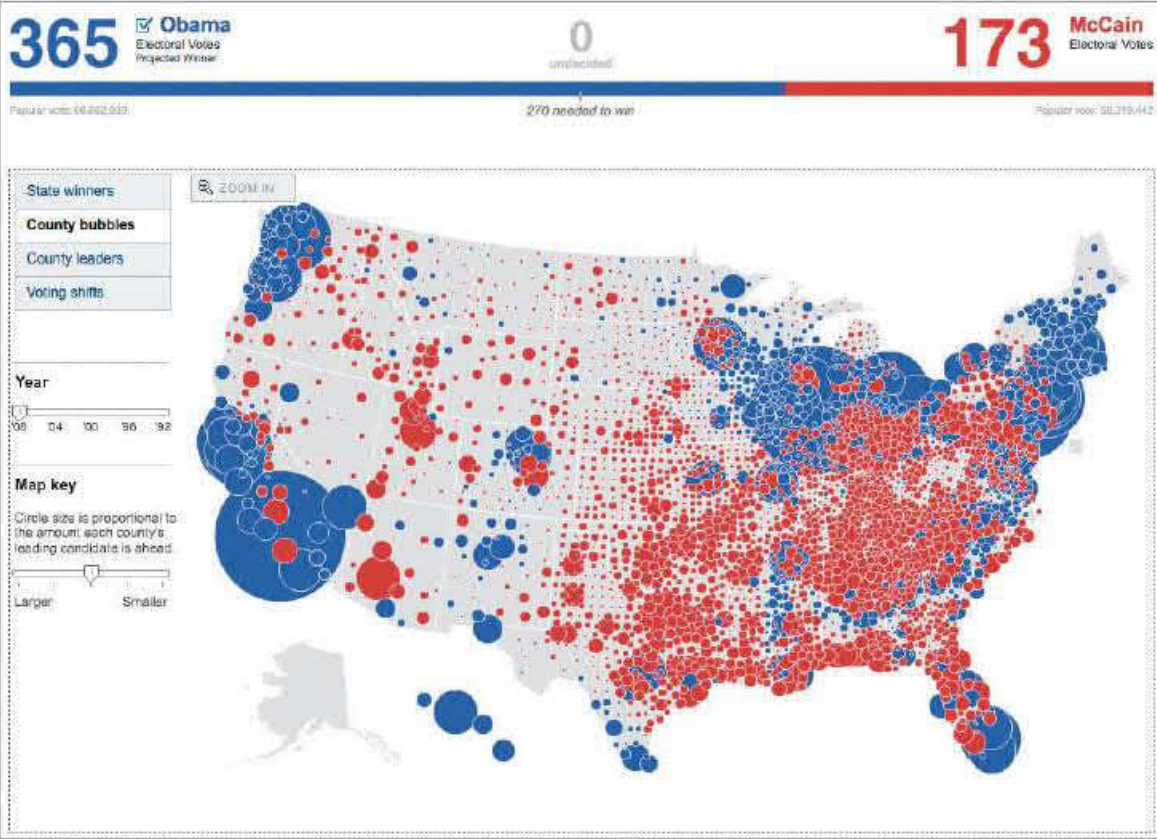
This 1858 map by Charles Minard is considered the first to have used graduated pie charts in maps.²² It portrays the amount of butcher's meat supplied by each French department to the Paris market between the years 1845 and 1853 ("Carte figurative et approximative des quantités de viandes de boucherie envoyées sur pied par les départements et consommées à Paris"). Each circle is scaled to represent the proportional quantities of meat supplied by the administrative departments. The wedges of the pie charts refer to relative amounts of beef (in black), veal (in red), and mutton (in green). The color encoding the base map stand for departments supplying meat (in yellow) and not supplying meat (in bistre). The departments lacking circles supplied meat, but in too small amounts to be noted.

Graduated symbol maps use the visual variable of size to proportionally represent magnitudes of thematic discrete data. The size is proportional to the quantities represented, but not dependent on the geographical area over which it stands. This characteristic helps avoid problems of confounding geographic area with data values, as in the case of choropleth maps (see page 142).

There are two main variables to consider when designing a graduated symbol map: the shape of the symbol and the scaling. The shape of the marks can vary, and the most common shape is the circle, although we see rectangular bars as well as triangles being used. There have been attempts at three-dimensional symbols, where the scaling is done to the cube rather than to the square root. But, if area perception is already hard in two dimensions, and often underestimated, then it gets even more problematic judging relative sizes of quantities provided by volumes. Glyphs have also been used for depicting more than one variable. The 1858 map by Minard is the first known example, where pie charts are used to portray different kinds of meat.

Selecting the scaling method is perhaps the biggest challenge in proportional symbol maps, as well as in choropleth maps. There are two ways to scale the size of symbols: classed, when size is range graduated, and unclassed, when sizes follow a proportional system.

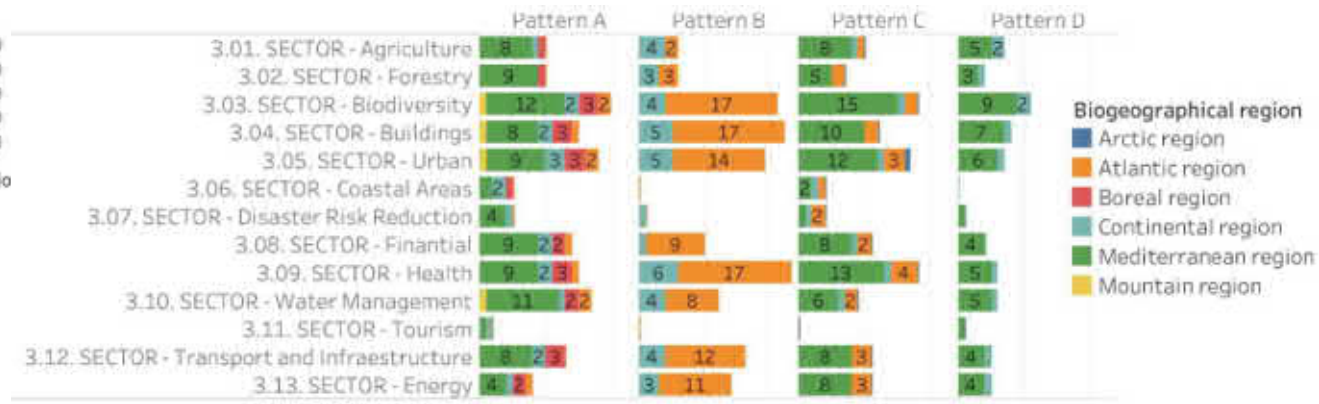
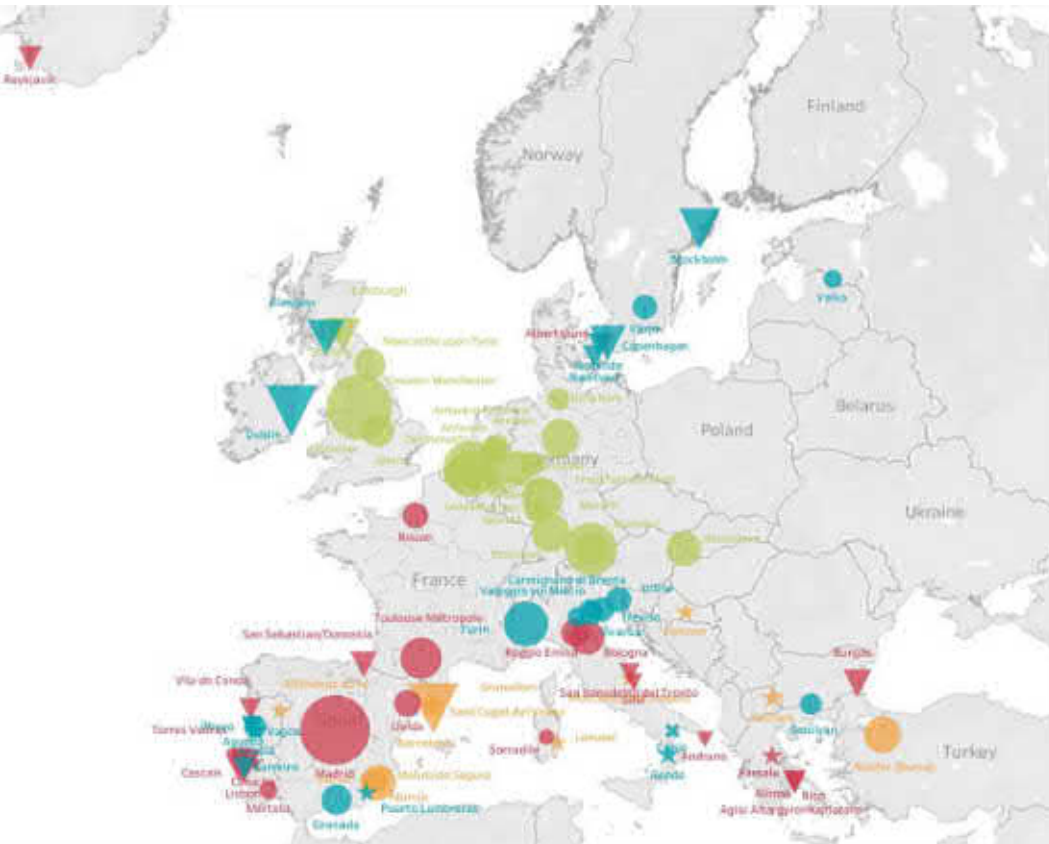
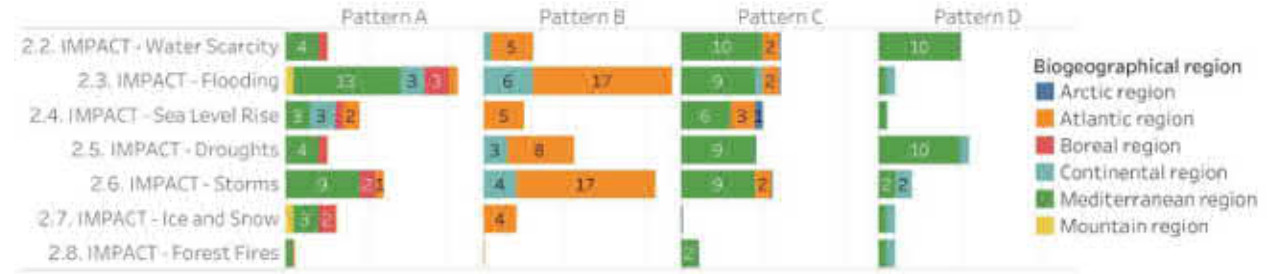
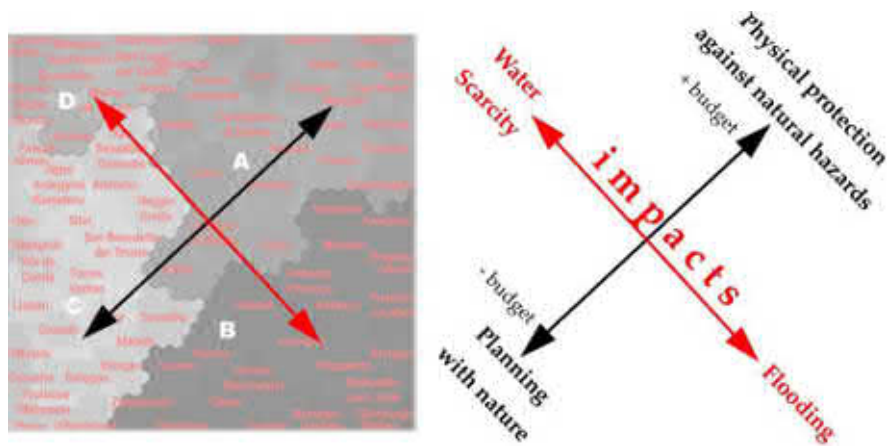
In unclassified systems, the number of categories is equal to the number of data values. If there are five values, then there will be five encodings. For representing a large number of values, the most common strategy is the use of percentages. This strategy is more commonly employed in choropleth maps using color value graduation, rather than for scaling symbols, because differentiation would be almost impossible.



Two issues should be considered in classed systems because they influence how data are represented and thus perceived: the number of classes and the method for dividing the data. A differing number of classes influences the patterns revealed in the visualization, and it is recommended to experiment with the number of groups before making a final decision. The same holds true for the methods used for breaking down quantities (see the box Making Meaningful Groups on page 141). It is highly recommended to first analyze the data to understand certain characteristics, such as distribution. For example, using quantile methods—dividing quantities into groups of equal numbers—for representing skewed data is a poor choice, in that identical values will be divided into different groups, and different values will be grouped together. Color values and color saturation might be used to map other data attributes; however, perception is hindered in small marks.

New York Times, U.S.:
"Election Results 2008," 2008.
During the presidential election in 2008, the *New York Times* published a series of visualizations showing votes by counties and state. The maps include data on previous elections back to 1992. For each year, the application allows viewers to select the visual technique used to represent the data. This spread focuses on the graduated dot symbolization. A comparison with the choropleth technique is available on the next page.

<http://elections.nytimes.com/2008/results/president/map.html>



Abarca-Álvarez, F.J., Navarro-Ligero, M.L., Valenzuela-Montes L.M. & Campos-Sánchez F.S. (2019). *European Strategies for Adaptation to Climate Change with the Mayors Adapt Initiative by Self-Organizing Maps*. Applied Sciences; 9(18):3859. <https://doi.org/10.3390/app9183859>

CHOROPLETH MAPS

Choropleth maps are perhaps the most popular technique for representing statistical data using area symbols. Choropleth maps typically display data that have been aggregated by administrative units (the area symbols), and the values have been normalized (e.g., densities, ratios, averages).

One of the problems with choropleth maps is that the size of the area base for the encoding—the administrative unit—influences the perception of the quantity being represented. To avoid confounding geographic area with data values, it is crucial that normalized data be used instead of absolute data. Densities, ratios, and averages should be calculated prior to encoding.

The visual variables used in choropleth maps to encode quantitative data include color value, color saturation, and texture, or a combination of them. Color hue is often used for differentiating between categorical data in the case of multivariate maps. Color value and saturation are ordered variables, whereas color hue is not. That is the reason color value is usually used in choropleth maps, which represent range-graded data. MacEachren warns, “A common objection by cartographers to maps of quantities produced by noncartographers is that these maps often ignore the importance of the linear order schema and employ a set of eye-catching (but randomly ordered) hues. Sometimes the hues are ordered, but according to wavelength of the hue. Wavelength ordering is not immediately recognized by our visual system, and therefore is unlikely to prompt the appropriate linear order schema on the part of the viewer.”⁵⁵

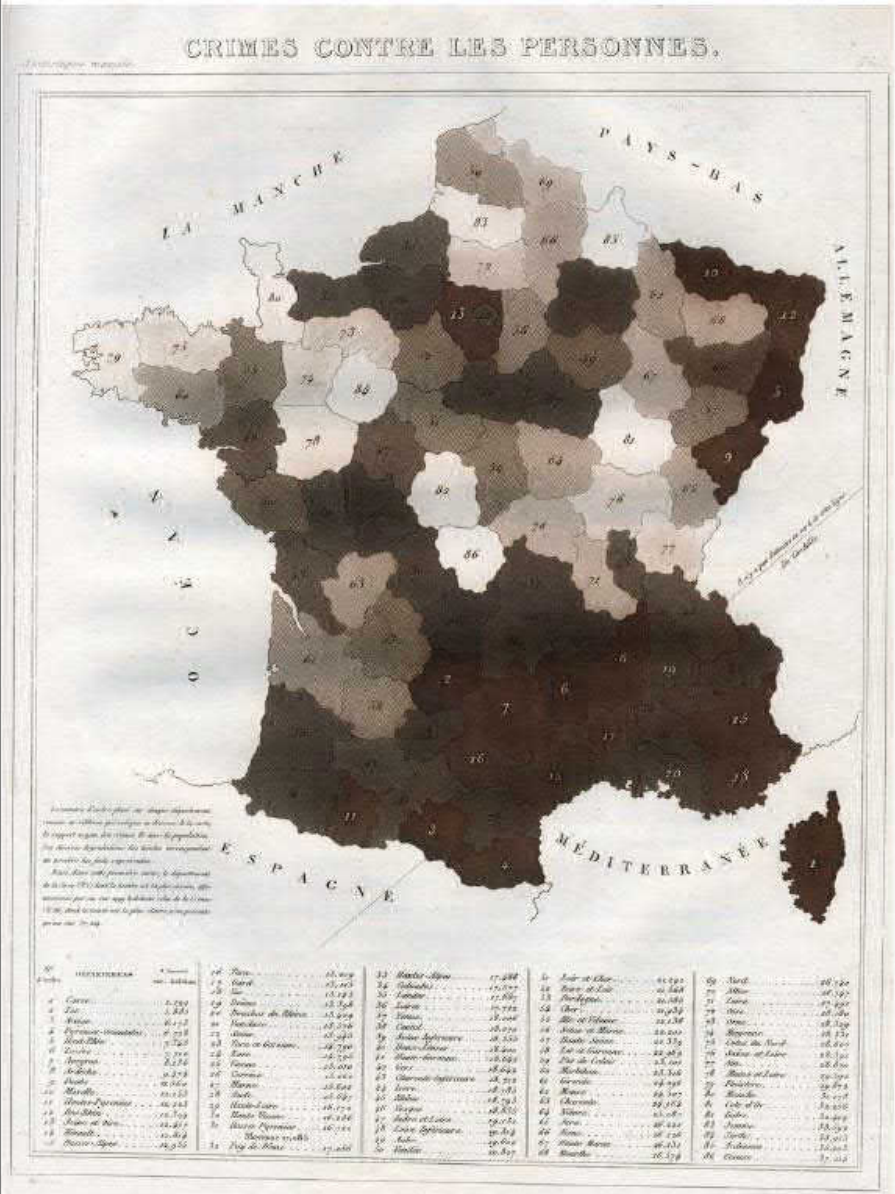
Legends should help viewers recognize the implicit order. For example, do darker colors represent higher quantities? The legend should provide the answer.

The elements to be considered when designing choropleth maps are the size and shape of the area unit, the number of classes, and the method used for classifying the data.

Because visual encoding is uniformly distributed within the regions of choropleth maps, the impression is that the phenomena represented are also uniformly distributed, which most often is not the case. The overall impression of the phenomena will be more meaningful if the statistical areas are of similar shape and small in size. Whenever possible, it is recommended to avoid using areas with large variation in size and shape. The maps by the *New York Times* showing political affiliation during the 2008 presidential election provide good comparison of impressions caused when the data are represented by state and by counties.

As already discussed in the case of graduated symbol maps, the number of classes as well as the way the data are divided into the groups influence the resulting patterns. There is extensive literature devoted to methods used to determine the boundaries of classes, and the box Making Meaningful Groups (page 141) offers a brief summary of most common methods. The distribution of the data will likely provide meaningful information for the number of classes. The methods can be used for defining classes in choropleth, isarithmic, and graduated symbol maps.

Data classification will largely influence which data features are emphasized and which are suppressed. If, on one hand, having a large number of classes provides more detailed results, then, on the other hand, there are limits to how many classes of color value (or texture) we are able to distinguish. There are also differences in how we perceive monochromatic versus color symbolizations. In general, it is safe to constrain the number of classes to a maximum of five to eight classes, because the range fits into a cognitively efficient zone (see the box Magical Number Seven on page 97).

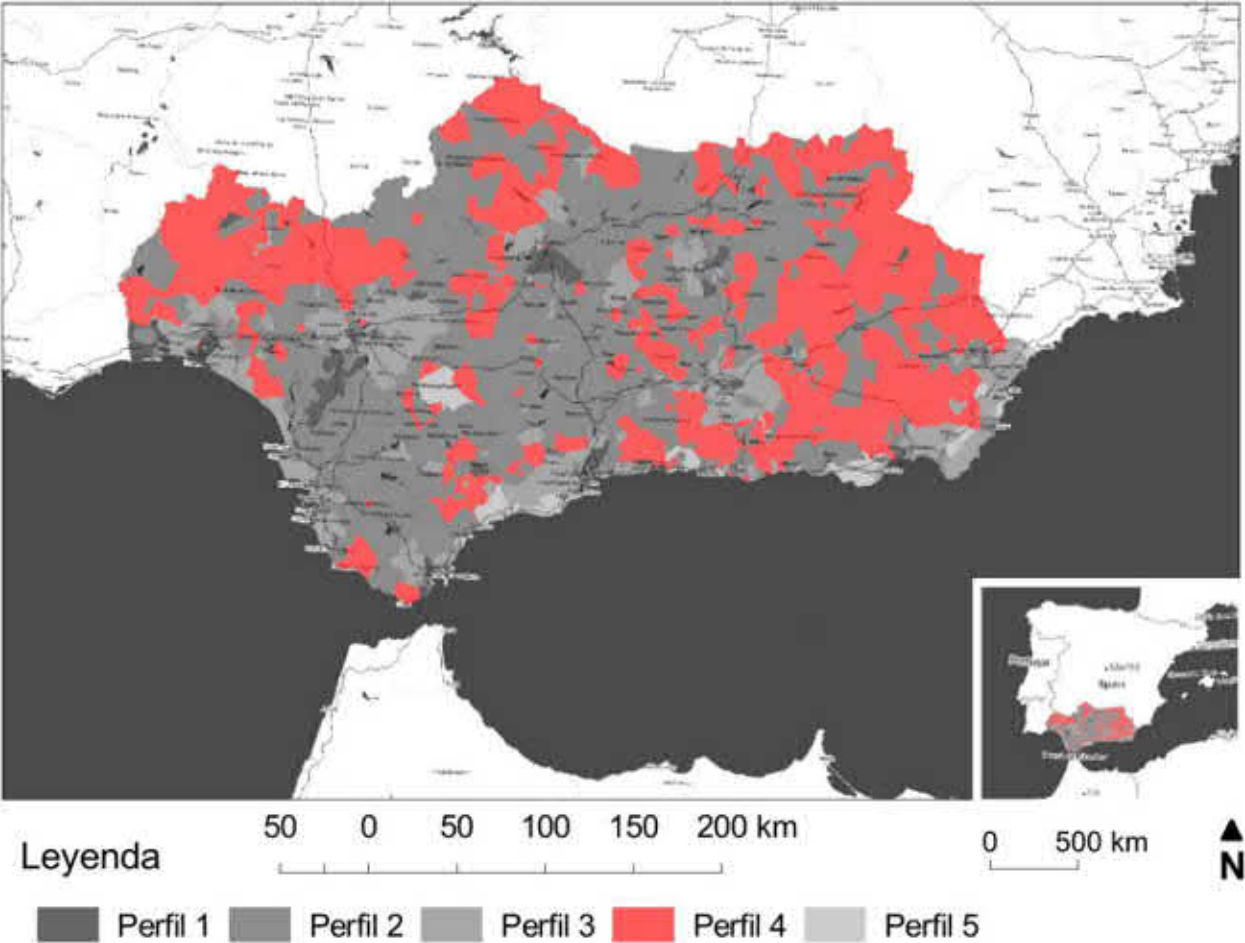
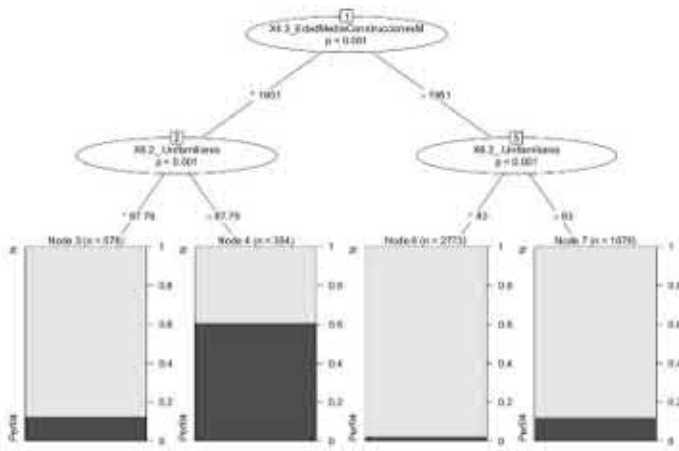


“Crimes contre les personnes” (Crimes Against People) was published in *Essai sur la statistique morale de la France* in 1833. The map depicts crime in France from 1825 to 1830 and was made by André-Michel Guerry, who is considered to have pioneered the mapping of criminal statistics.⁵⁶ There are seven shades representing different levels of crime, from dark brown (more crimes) to white (fewer crimes). Each administrative department is ranked, and the map includes the numbers. The list at the bottom provides the absolute numbers of crimes committed in each department. Note that Corsica, which belonged to France at that point in time, had the highest crime rate.



World Food Programme (2022) HungerMap.
<https://hungermap.wfp.org/>

	Muestra completa		Perfil 4			
N de instancias (%)	5381	100.00	550		10.22%	
Atributo	Media	DS	Media	DS	conf	TE
2.1_EquipSaludPor1000Hab	1.39	6.16	1.56	2.45	ns	
2.1_EquipEducacionPor1000Hab	1.14	2.36	2.16	3.20	***	+
2.1_EquipBienestarPor1000Hab	0.83	1.68	1.85	3.77	***	++
2.1_EquipCulDepPor1000Hab	0.72	1.47	1.94	3.07	***	+++
2.1_EquipamientosPor1000Hab	4.08	8.31	7.51	7.25	***	+
2.2_%NoAguaCorriente	0.91	2.84	3.16	6.47	***	++
2.2_%Gas	22.77	33.76	12.31	28.29	***	-
2.2_%Telefono	86.96	17.48	63.45	23.69	***	--
2.5_%PocaLimpiezaCalles	35.10	19.82	21.23	22.00	***	--
2.6_%Delincuencia	25.32	23.67	4.94	10.62	***	--
3.1_Poblacion	1367	518.00	900.20	410.50	***	--
3.1_EdadMediaPoblacion	38.01	4.41	42.74	4.02	***	+++
3.1_%Nacimientos	11.32	3.21	9.54	2.78	***	--
3.2_PersonasPorEdificio	14.46	22.91	2.43	3.79	***	--
3.2_%Hogares1Adulto	18.80	7.55	27.87	7.37	***	+++
3.2_%Hogares1adultoYMenor	1.83	1.12	1.28	0.92	***	-
3.2_%Hogares2adulto	41.24	6.75	41.01	5.11	ns	
3.2_%Hogares3adulto	18.41	3.36	16.53	3.13	***	--
3.2_%Hogares4adulto	19.71	6.64	13.32	4.70	***	--
3.2_Hogares	449.20	167.50	340.20	145.70	***	--
3.2_HabitantesPorHogar	3.04	0.36	2.62	0.31	***	--
3.2_RatioEdiViviendasPorHogar	0.74	0.56	1.42	0.48	***	+++
3.3_%PoblacionArraigada	80.11	9.49	82.19	5.00	***	+
3.3_%PoblacionInmigranteProvincial	3.87	5.81	3.83	3.52	ns	
3.3_%PoblacionInmigranteRegional	1.35	1.28	0.97	1.09	***	-
3.3_%PoblacionInmigranteNacional	1.58	1.33	1.89	1.59	***	+
3.3_%PoblacionInmigranteExtranjero	1.32	2.79	1.13	1.95	*	
3.3_%España	97.92	4.58	98.58	2.68	***	
3.3_%EuropaUE	0.77	2.97	0.82	2.21	ns	
3.3_%EuropaNoUE	0.18	0.56	0.12	0.38	***	
3.3_%AmericaDelNorte	0.05	0.18	0.02	0.08	***	
3.3_%AmericaCentral	0.04	0.09	0.01	0.05	***	-
3.3_%AmericaDelSur	0.41	0.83	0.20	0.47	***	-
3.3_%Asia	0.08	0.34	0.02	0.12	***	
3.3_%Africa	0.54	2.01	0.23	1.05	***	
3.3_%Oceania	0.00	0.02	0.00	0.01	***	
3.3_%Apatridas	0.00	0.01	0.00	0.00	***	
3.4_%TrabajaEnProvincia	6.43	5.48	6.81	4.43	*	
3.4_%TrabajaEnRegion	0.87	1.00	0.98	0.95	**	
3.4_%TrabajaEnEspaña	0.47	0.57	1.00	1.26	***	+++
3.4_%TrabajaOtroPais	0.12	0.29	0.16	0.53	ns	
4.1_%Ocupados	33.19	6.51	27.38	7.11	***	--
4.1_%Parados	10.48	5.11	12.95	7.53	***	+
4.1_%Inactivos	38.02	7.24	43.94	7.25	***	+++
4.2_LocalComercialPor1000Hab	26.90	98.90	19.40	20.90	***	
4.2_OficinaYServiciosPor1000Hab	10.70	44.60	8.10	12.20	***	
4.2_Industrial1000Hab	3.07	12.11	3.63	7.94	ns	
4.2_LocalAgrario1000Hab	0.65	6.71	3.14	19.84	**	+
4.2_LocalInactivoPor1000Hab	13.37	20.22	19.63	29.47	***	+
4.3_EstadoConstruccionesD	0.40	0.23	0.50	0.21	***	+
4.4_IDH_COMBINADO-	0.00	0.00	0.00	0.00	***	+
4.4_IDH_COMBINADO+	0.00	0.00	0.00	0.00	ns	
4.4_IDH_COMBINADO	0.00	0.00	0.00	0.00	***	+
4.5_%AgriculturaGanaderia	4.16	6.06	7.28	5.74	***	++
4.5_%Pesca	0.14	0.59	0.03	0.12	***	
4.5_%Industria	3.81	2.46	2.81	2.18	***	-
4.5_%Construccion	4.47	2.44	4.35	2.08	ns	
4.5_%Servicios	20.61	8.12	12.91	4.83	***	--
4.5_%Paro	24.09	11.26	31.61	16.40	***	++
4.6_%ViviendaEnPropiedad	82.28	13.30	82.73	10.10	ns	
4.6_%ViviendasEnAlquiler	9.39	11.29	5.05	5.16	***	-

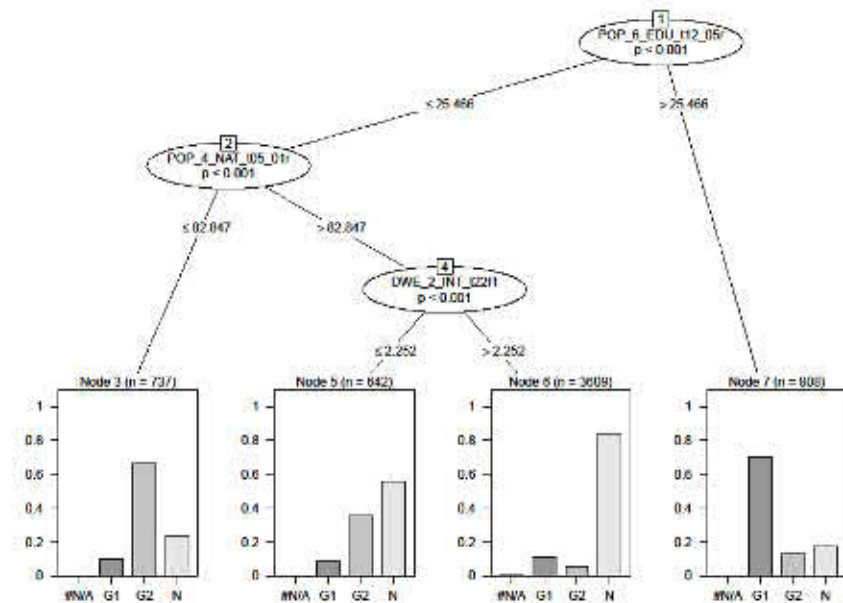
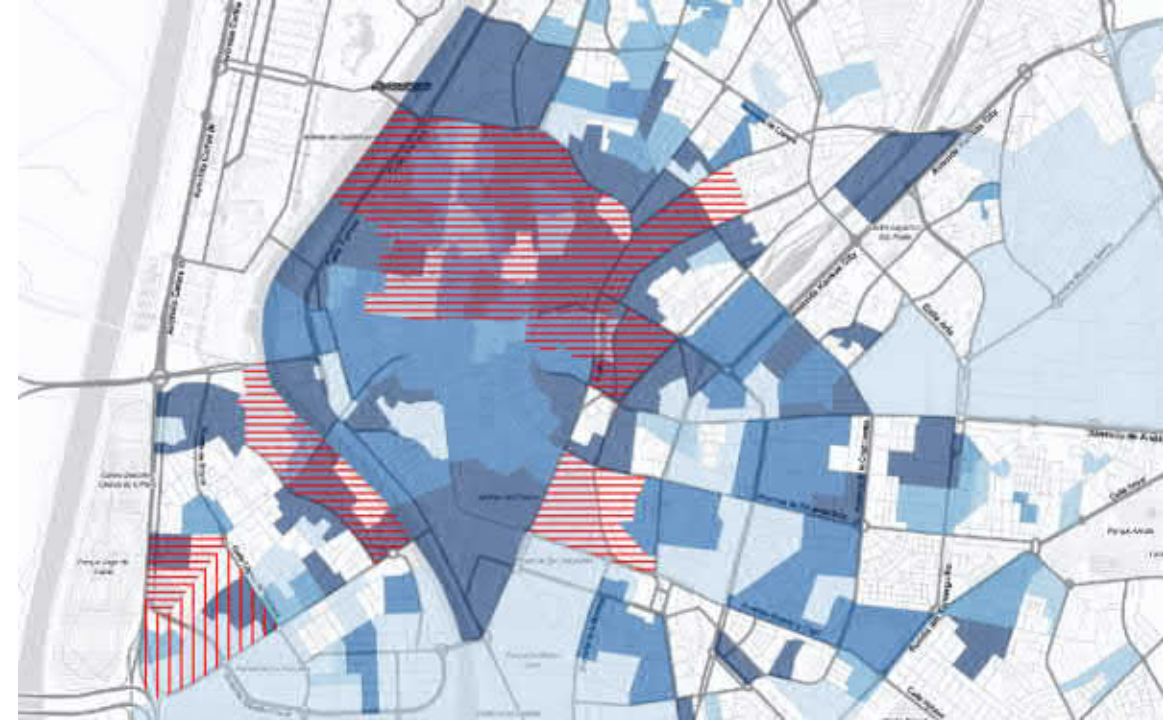
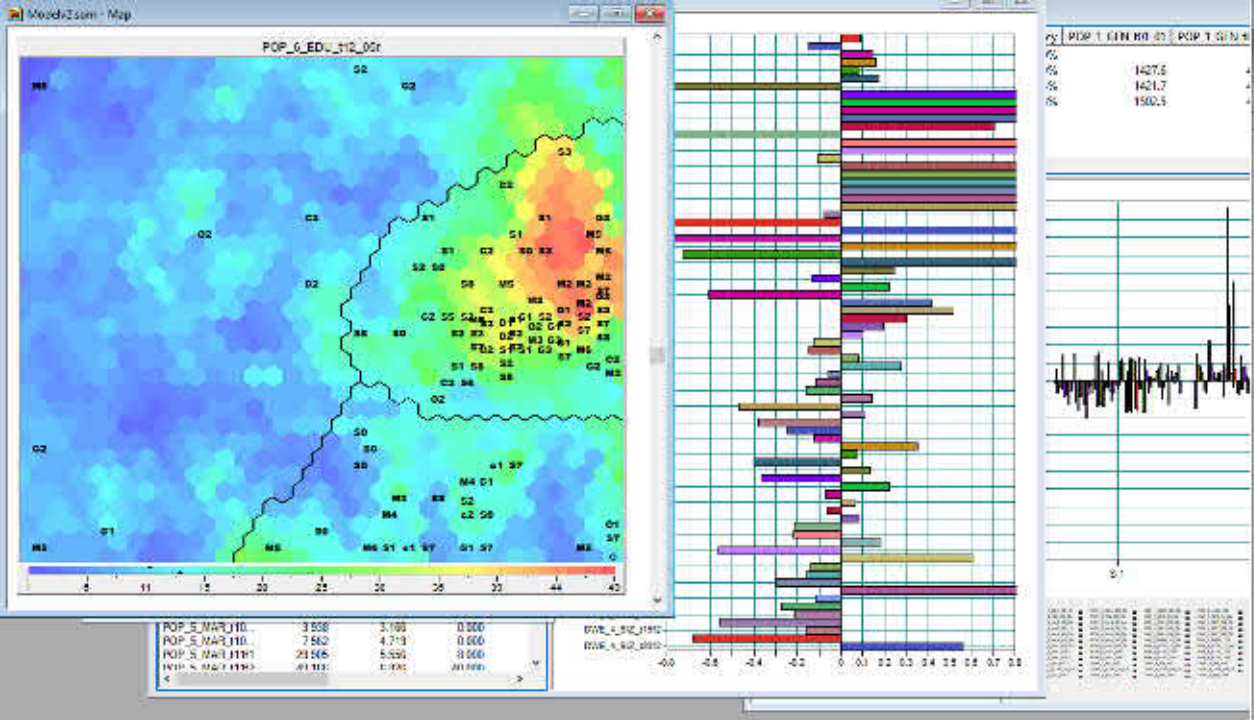


Abarca-Alvarez, FJ & Campos-Sánchez, FS. (2018).

Inteligencia Artificial para la Inteligencia Urbana: Sistema de Ayuda a la Decisión para la predicción de la vulnerabilidad social.

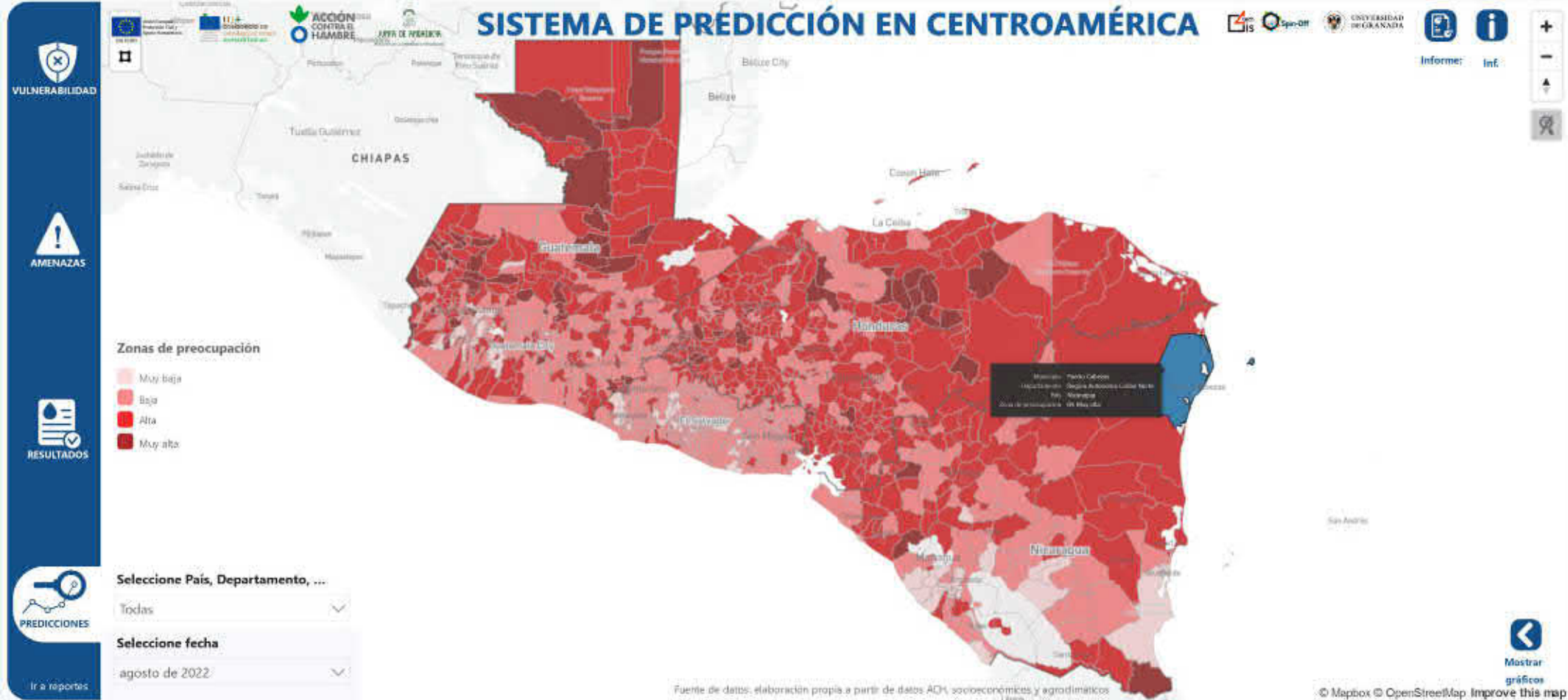
In Libro de Actas XVIII Conferencia de la Asociación Española para la Inteligencia Artificial (CAEPIA). Editorial Universidad de Granada. Granada 23-26 octubre 2018.

https://sci2s.ugr.es/caepia18/proceedings/docs/CAEPIA2018_paper_266.pdf



Abarca-Álvarez et al. (2019)
 Detección de gentrificación a partir de datos demográficos.

Detecting gentrification using demographic data.



GIS4tech (2022) Sistema de Predicción en Centroamérica.
Zonas de preocupación de la Seguridad Alimentaria y Nutricional
<https://predisan.gis4tech.com/CA4>

Prediction System in Central America. Areas of Concern Regarding Food and Nutritional Security

ISOMETRIC AND ISOPLETH MAPS

Isarithmic maps represent real or abstract three-dimensional surfaces by depicting continuous phenomena. There are two kinds of lines of equal value used to demarcate continuous surfaces on the map:

- Isometric lines show distribution of values that can be referenced to points.
- Isopleth lines show distribution of values that cannot be referenced to points.⁴¹

In isometric maps, the lines depict data values at specific points on a continuous distribution. In other words, the dataset provides data points that define the lines. Topographic maps and temperature maps are good examples of data that are measured at specific locations.

In isopleth maps, the lines depict data that were not measured at a point, but instead are derived values that are calculated in relation to the area of collection. The calculated centroid of each area is considered the data point for the line construction. Isopleth maps representing population density are examples. Maps representing the mean monthly temperatures or average precipitation levels are common examples in which data are derived from observations, though they are slightly different from density maps, in which the attribute value cannot be referenced to points.

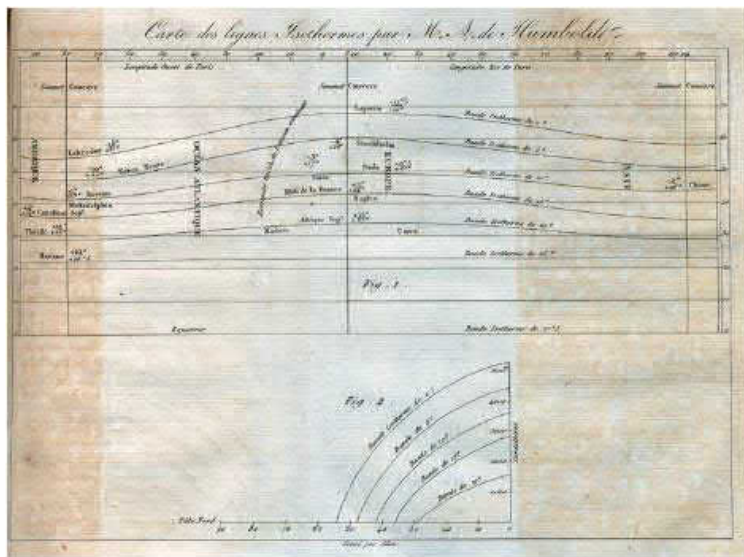
In both cases, smooth contours are achieved by the interpolation of data points. When used without the shading, they are called isoline maps. A variation is provided by a planimetric three-dimensional graphic representation of the surfaces.

Edmond Halley's 1701 map of magnetic lines is considered the first map to make use of lines of equal value to encode data (see page 116). The first isopleth maps depicting population densities were created by Danish cartographer N. F. Ravn and published in 1857. Robinson explains, "An isopleth map of population densities employs an involved, graphic, geometric symbolism for describing a three-dimensional surface to show the structure of an imagined 'statistical surface' formed by the variations in ratios of people to areas. An 'ordinary' contour map is in reality a very complicated system of representation, and the concept of a statistical surface of population densities is exceedingly abstract. That the two could be combined by the 1850s, and readily accepted, shows how far thematic mapping had come."⁴² The use of isolines to represent population data is less popular today. The majority of isarithmic maps that we encounter nowadays show natural phenomena, such as climate and geology.

The construction of isarithmic maps involves three elements: the location of control points, the interpolation method to connect the location points, and the number of control points.

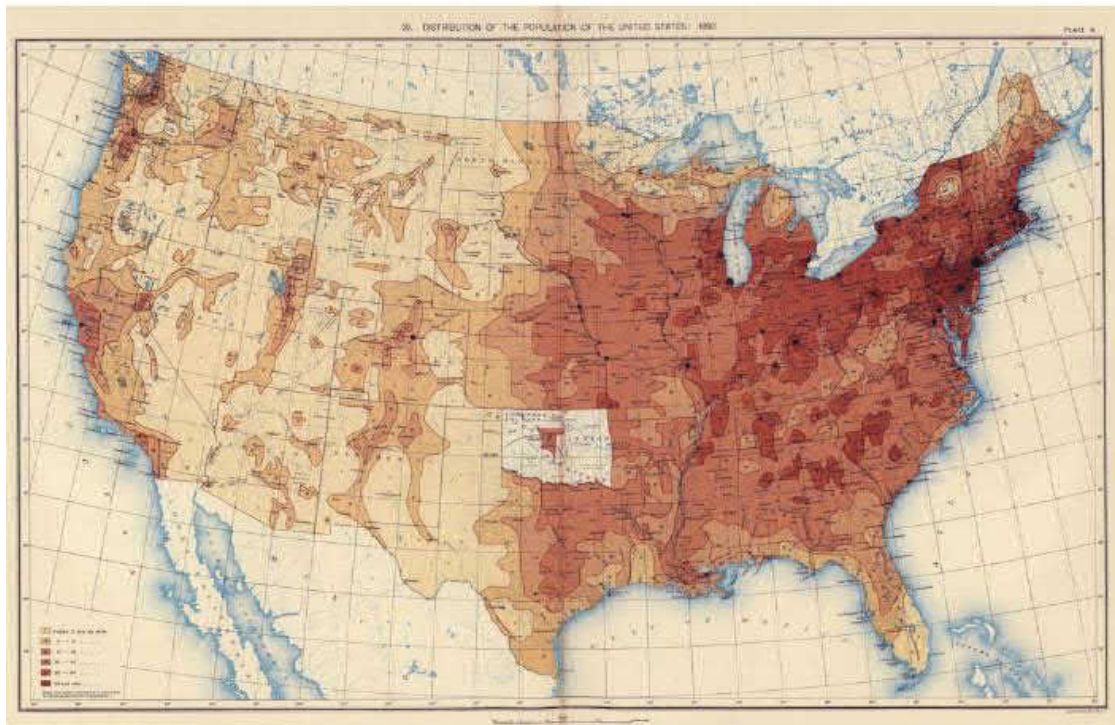


The *Physikalischer Atlas* by Heinrich Karl Wilhelm Berghaus (1797–1884) is considered a monumental achievement in thematic cartography history.⁴³ The atlas was issued over several years, and the first edition of the bound atlas consists of ninety maps in two volumes, dated 1845 and 1848. This meteorological map is the second map in the atlas. Using a polar projection, Berghaus depicted the mean temperature in the Northern Hemisphere by drawing isotherm lines at 5°C intervals.



The publication in 1817 of this "Chart of Isothermal Lines" by Alexander von Humboldt played an important role in the widespread use of curves to depict quantitative phenomena in the nineteenth century, even though the first use was by Halley a century earlier. The diagram depicts lines of average temperature in relation to geographical zones defined by the latitude/longitude system. It also coins the term isotherms for the technique.⁴⁸

The map shows the distribution of the population of the United States in 1890. It was part of the *Statistical Atlas of the United States* based upon the results of the eleventh census by Henry Gannett, published in 1898. Note the six classes, with darker shades standing for higher density. Cities with over 8,000 inhabitants are represented by black circles with scale proportionate to their population.

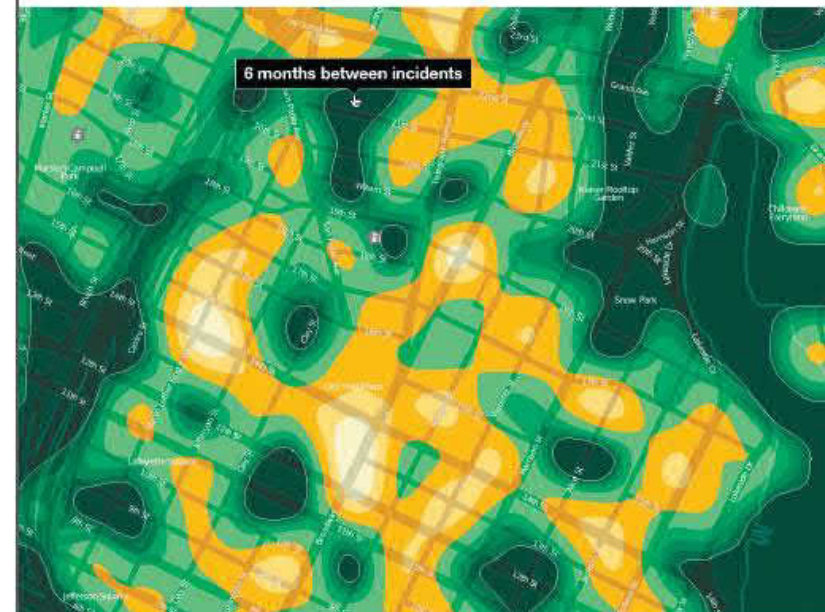


Michal Migurski, Tom Carden, and Eric Rodenbeck (Stamen Design), U.S.: "Oakland Crimespotting," 2008.

Oakland Crimespotting was designed and built by Stamen Design's Michal Migurski, Tom Carden, and Eric Rodenbeck. It is an interactive map showing crimes in Oakland, California. The motivation is stated on the website: "Instead of simply knowing where a crime took place, we would like to investigate questions like: Is there more crime this week than last week? More this month than last? Do robberies tend to happen close to murders? We're interested in everything from complex questions of patterns and trends, to the most local of concerns on a block-by-block basis."⁴⁹

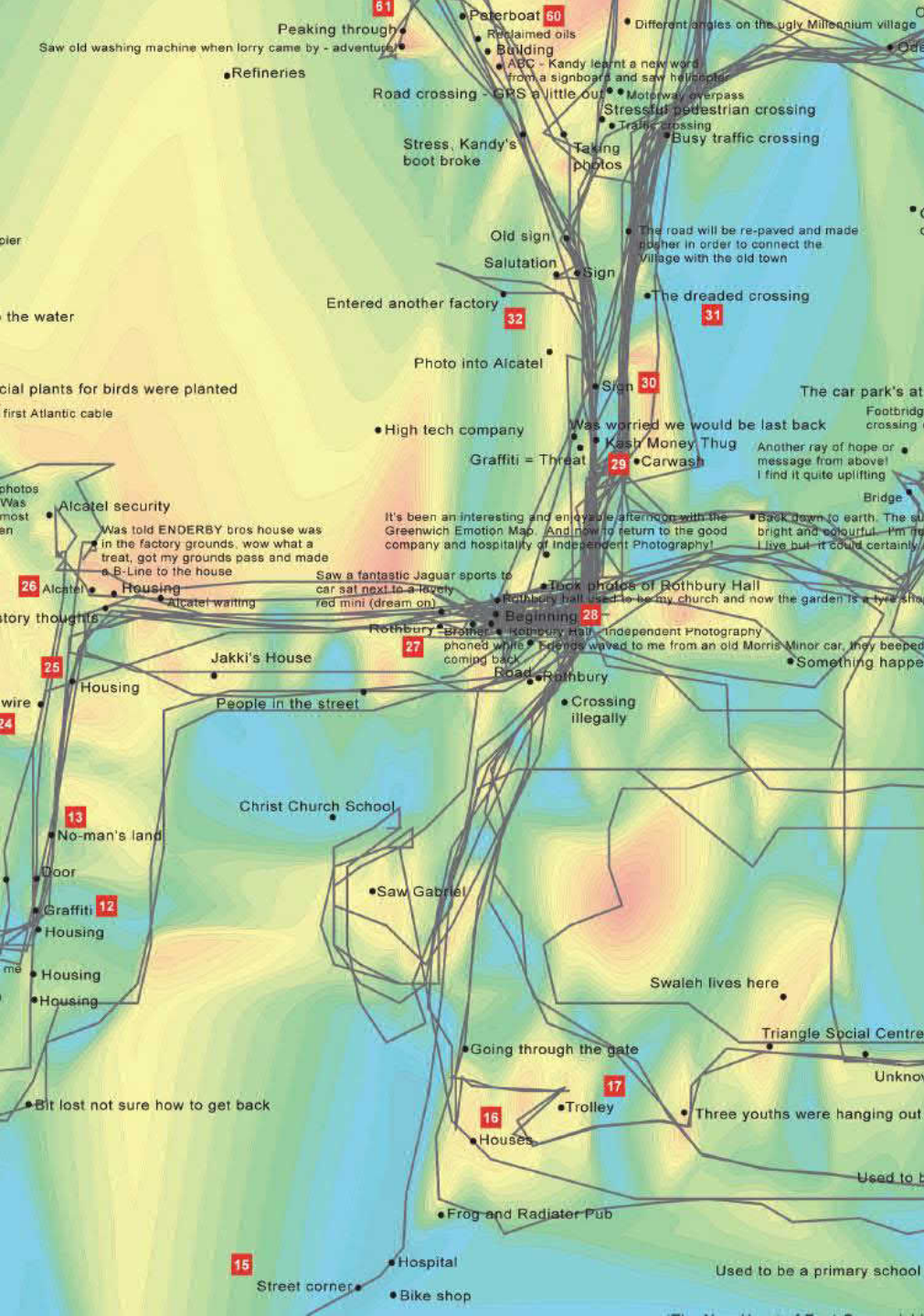
The application is a work in progress since 2008, and the screenshots shown here are not built into the interactive tool available online. On the other hand, they are worth reproducing here, because it is an effective use of isopleth for visually answering some of the questions that motivated the work.

<http://oakland.crimespotting.org>



In Meirelles, I. (2013). *Design for Information* (Vol. 5).

<http://doi.org/10.1017/CBO9781107415324.004>



Greenwich Emotion Map

Nold, C. (2009). *Emotional Cartography*.

Retrieved from <http://www.emotionalcartography.net>

FLOW AND NETWORK MAPS

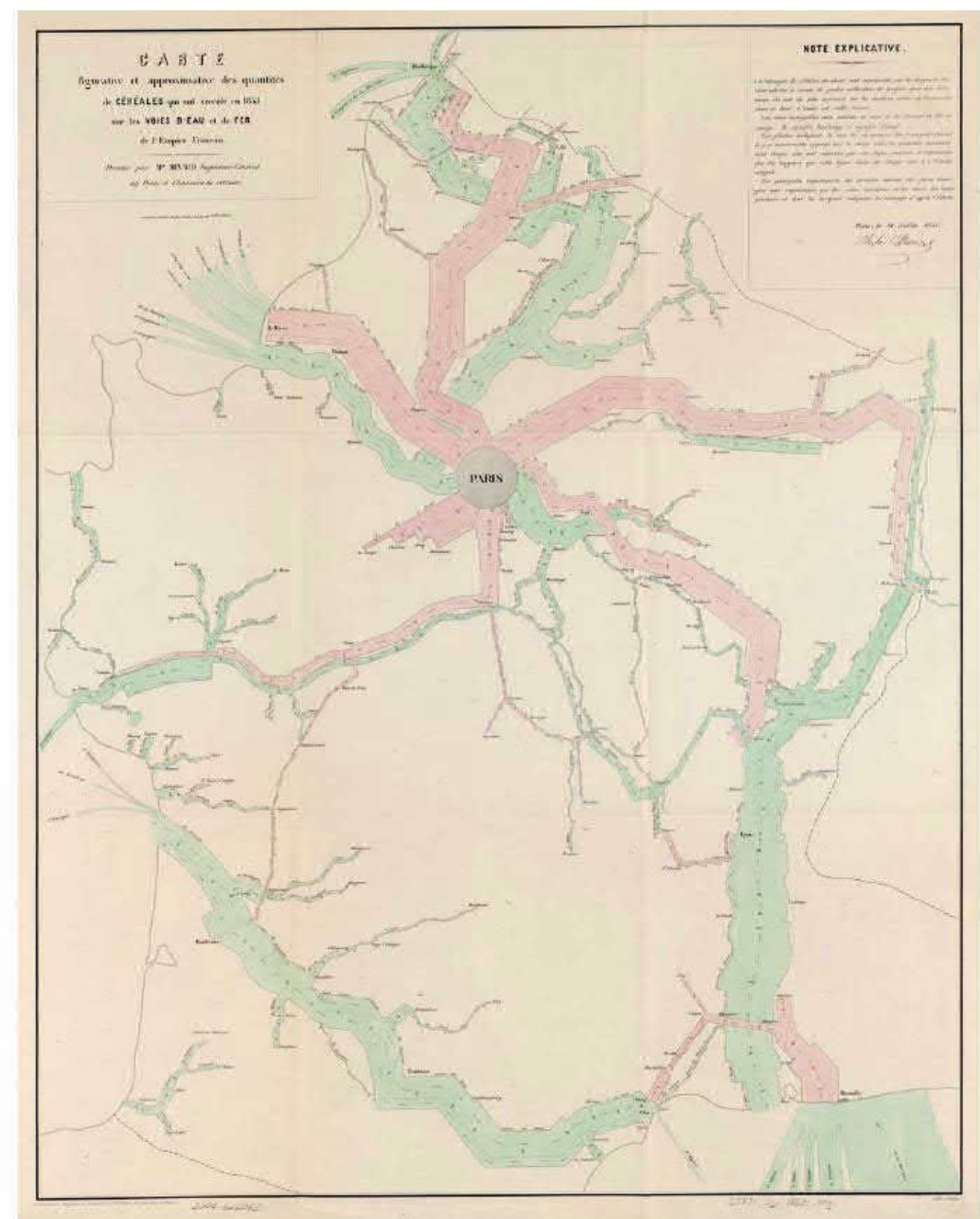
Flow and network maps portray linear phenomena that most often involve movement and connection between points: origins and destinations. Maps depicting the flow of migrations in the world or the network of friends on Facebook are examples (see page 50). Most maps encode multivariate data using the visual attributes of line width, line quality, color hue, and spatial properties, the latter of which are provided by the geo-location of the data.

The first known flow maps were made by Harness, who published three of such maps in 1837, mostly depicting the average number of passengers on the Irish railway system. It is unknown whether those became available to other mapmakers, but around the mid-1840s Alphonse Belpaire in Belgium and Charles Joseph Minard in France also began making flow maps. Minard (1781–1870) was a prolific cartographer and produced fifty-one thematic maps mostly focusing on economic geography, of which the majority (forty-two) were flow maps.²⁴ According to Robinson, “Minard clearly outdid Harness and Belpaire in the number, variety, and sophistication of his thematic maps of movement.”²⁵

We see a boom in flow and network maps due to the amount of spatio-temporal data currently available. Robinson contends, “Like the dot map and the dasymetric technique, their [flow maps by Minard] sophisticated cartographic methods would have to be reinvented.”²⁶

This 1855 map by Charles Joseph Minard depicts the approximate amount of cereals that circulated by land and water in France in the year 1853. “*Carte figurative et approximative des quantités de céréales qui ont circulé en 1853 sur les voies d’eau et de fer de l’Empire Français.*” The visual encoding is:

1. **Spatial position:** The lines are geo-located according to the given trajectories. A sense of direction is also represented with arrows.
2. **Line width:** The width is proportional to the amount of cereals transported (the quantitative thematic variable). Note that the widths are different for the transport to and from Paris, which are divided by a dotted line. Numeric information is also written within the lines.
3. **Color hue:** Lines are colored according to the means of transport, whether it was via boat (green) or train (red).



In Meirelles, I. (2013). *Design for Information* (Vol. 5).

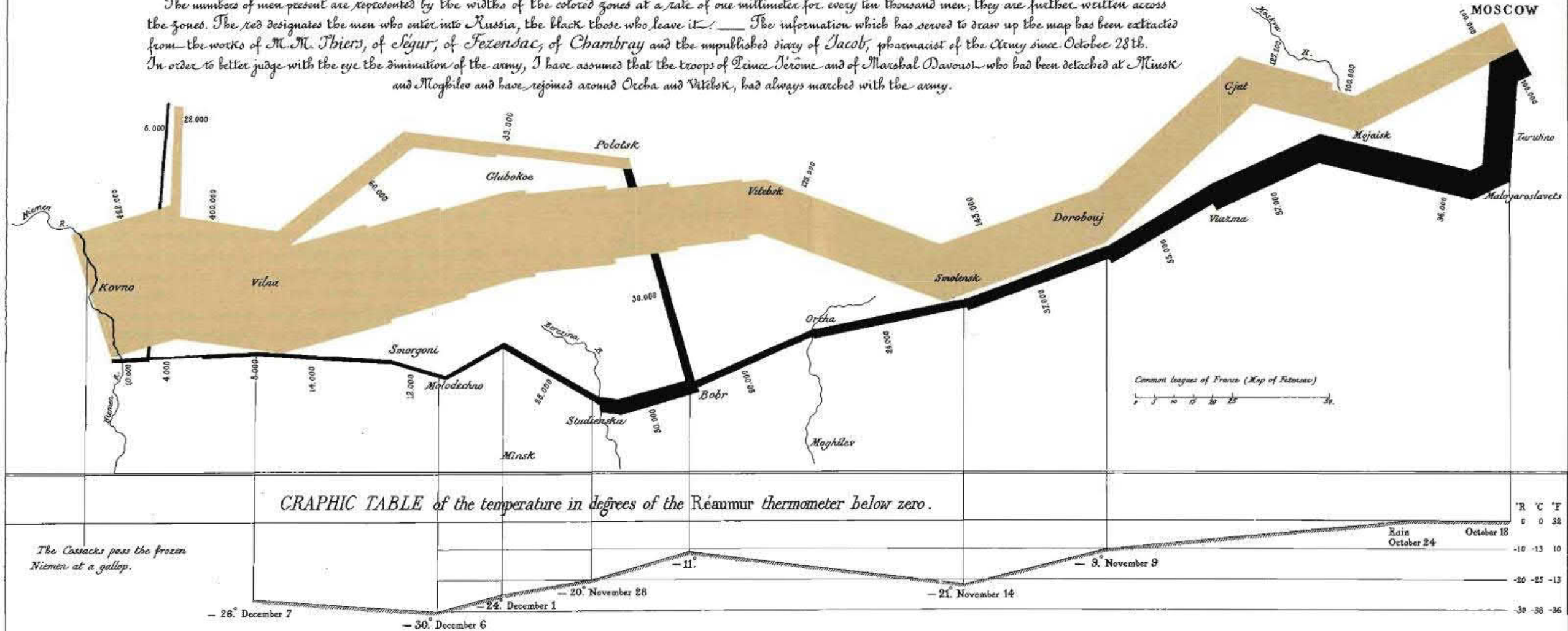
<http://doi.org/10.1017/CBO9781107415324.004>

Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812-1813.

Drawn up by M. Minard, Inspector General of Bridges and Roads in retirement.

Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who enter into Russia, the black those who leave it. — The information which has served to draw up the map has been extracted from the works of M. M. Thiers, of *Sigur*, of *Fezensac*, of *Chambray* and the unpublished diary of *Jacobi*, pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davoust who had been detached at Minsk and Mogilev and have rejoined around Orcha and Vitelsk, had always marched with the army.



The Cossacks pass the frozen Niemen at a gallop.

GRAPHIC TABLE of the temperature in degrees of the Réaumur thermometer below zero.

Common leagues of France (Map of Fédérations)

R C F

U D 32

6-13 10

3713 10

0-95-13

3-20-13

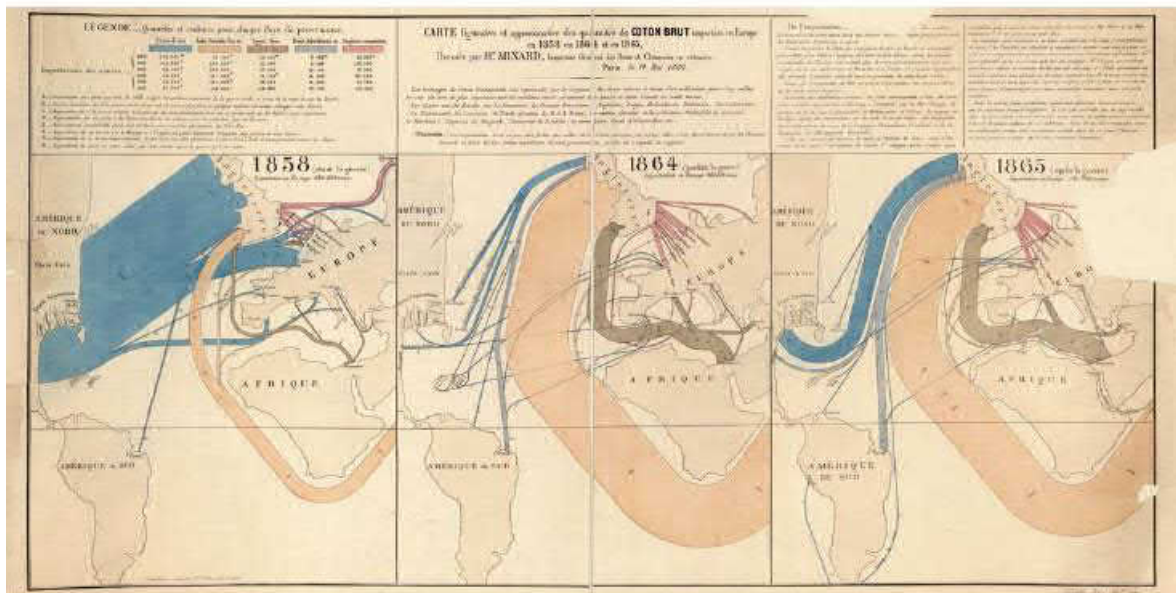
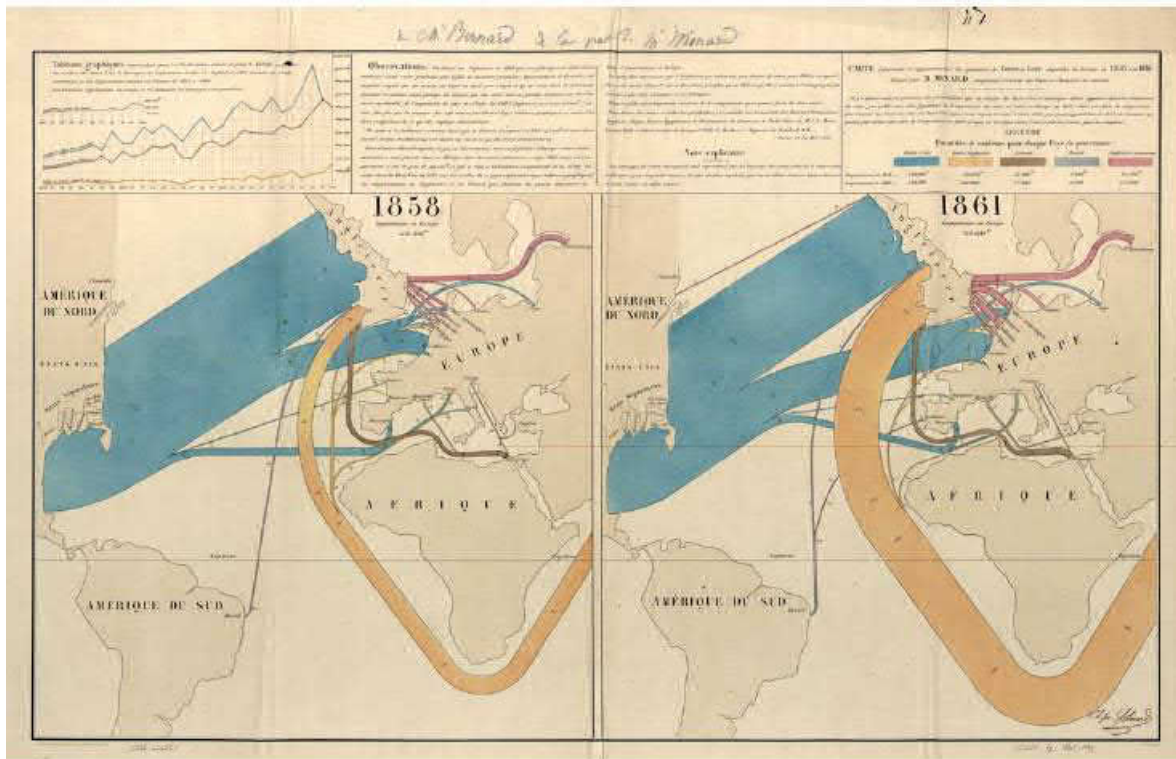
0-38-36

1000

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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J. Bourdieu.

*"Mapa figurativo de las sucesivas pérdidas de hombres de la Armada Francesa en la campaña de Rusia 1812-1813".
Minard*

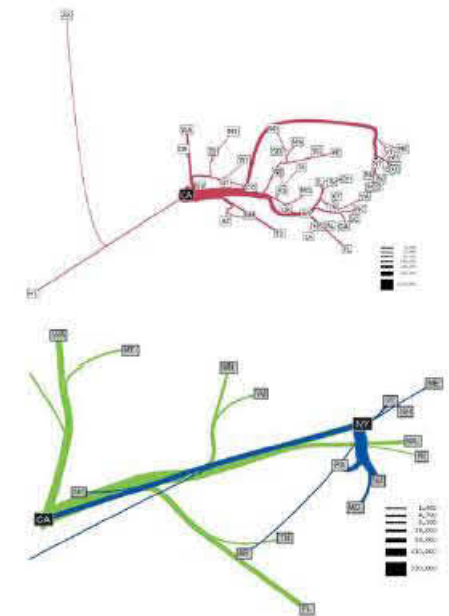


Two major challenges of designing flow maps are obfuscating the base map with the bands and avoiding too many overlaps and thus visual clutter. Minard met both challenges when he created flow maps in the nineteenth century. The two series of flow maps depict the approximate amounts of cotton imported by Europe. The map on the top, "Carte figurative et approximative des quantités de coton en laine importées en Europe en 1858 et en 1861," was published in 1862 and portrays data for 1858 and 1861. The map at the bottom, "Carte figurative et approximative des quantités de coton brut importées en Europe en 1858, en 1864 et en 1865," was published in 1866 and depicts data for three years: 1858, 1864, and 1865.

The reason for reproducing both maps here is so that we can examine how Minard distorted the base maps in favor of the flows of goods, which is the objective of the maps. If we compare the two series of maps, we will see how the one at the bottom, with increasing flow of goods over the years, depicts a more distorted geography, though distortion happens in the former as well. Robinson explains that Minard "was much more concerned with portraying the basic structure of the distribution than he was with maintaining strict positional accuracy of the geographical base—this from an engineer!"²⁸

Another feature still in current practice and worth stressing is how Minard bundled flows with shared destinations so as to avoid visual clutter.

In both maps, each millimeter corresponds to 5,000 tons of cotton. In addition to the visual representation provided by the width of bands, Minard included the absolute numbers next to each band. Color encodes the countries from which cotton is imported. The notes, as usual, present commentary on findings and questions. For example, in the maps on the bottom, Minard discusses how the American Civil War affected the commerce of cotton and the countries that were producers.



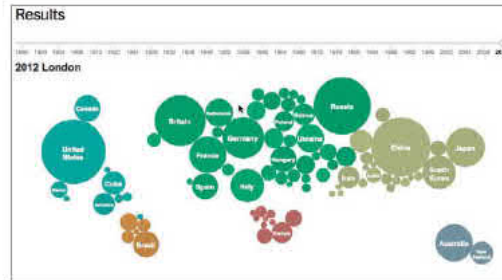
Doantam Phan, Ling Xiao, Ron Yeh, Pat Hanrahan, Terry Winograd (Stanford University), U.S.: "Flow Map Layout," 2005.

Phan and colleagues developed a technique to automatically generate flow maps that uses three lessons learned from Minard: intelligent distortion of spatial positions, intelligent edge routing, and merging of edges with shared destinations.²⁹ They explain, "Our approach uses hierarchical clustering to create a flow tree that connects a source (the root) to a set of destinations (the leaves). Our algorithm attempts to minimize edge crossings and supports the layering of single-source flow maps to create multiple-source flow maps. We do this by preserving branching substructure across flow maps with different roots that share a common set of nodes."³⁰

The top image shows a flow map of migration from California from 1995 to 2000, generated automatically by their system using edge routing but no layout adjustment. The bottom image shows a map of the top ten states that migrate to California and New York, showing that New York attracts more people from the East Coast and California attracts people from more geographic regions.

http://graphics.stanford.edu/papers/flow_map_layout

AREA AND DISTANCE CARTOGRAMS



Lee Byron, Amanda Cox, and Matthew Ericso
(*New York Times*), U.S.: "A Map of Olympic
Medals," 2012.

As opposed to traditional maps, in which space is used to depict space, cartograms distort the shape of geographic regions to encode another variable into the spatial area. There are different types of cartograms, and the one used in "A Map of Olympic Medals" is called a Dorling cartogram. The technique represents geographic space as nonoverlapping circles. The map was designed by Lee Byron, Amanda Cox, and Matthew Ericso, and published as an interactive map at the *New York Times* online in 2012 for occasion of the London Olympic Games. The screenshots show the results for 2012. Size represents the number of medals that countries won in the Olympic Games. Color encodes the continents.

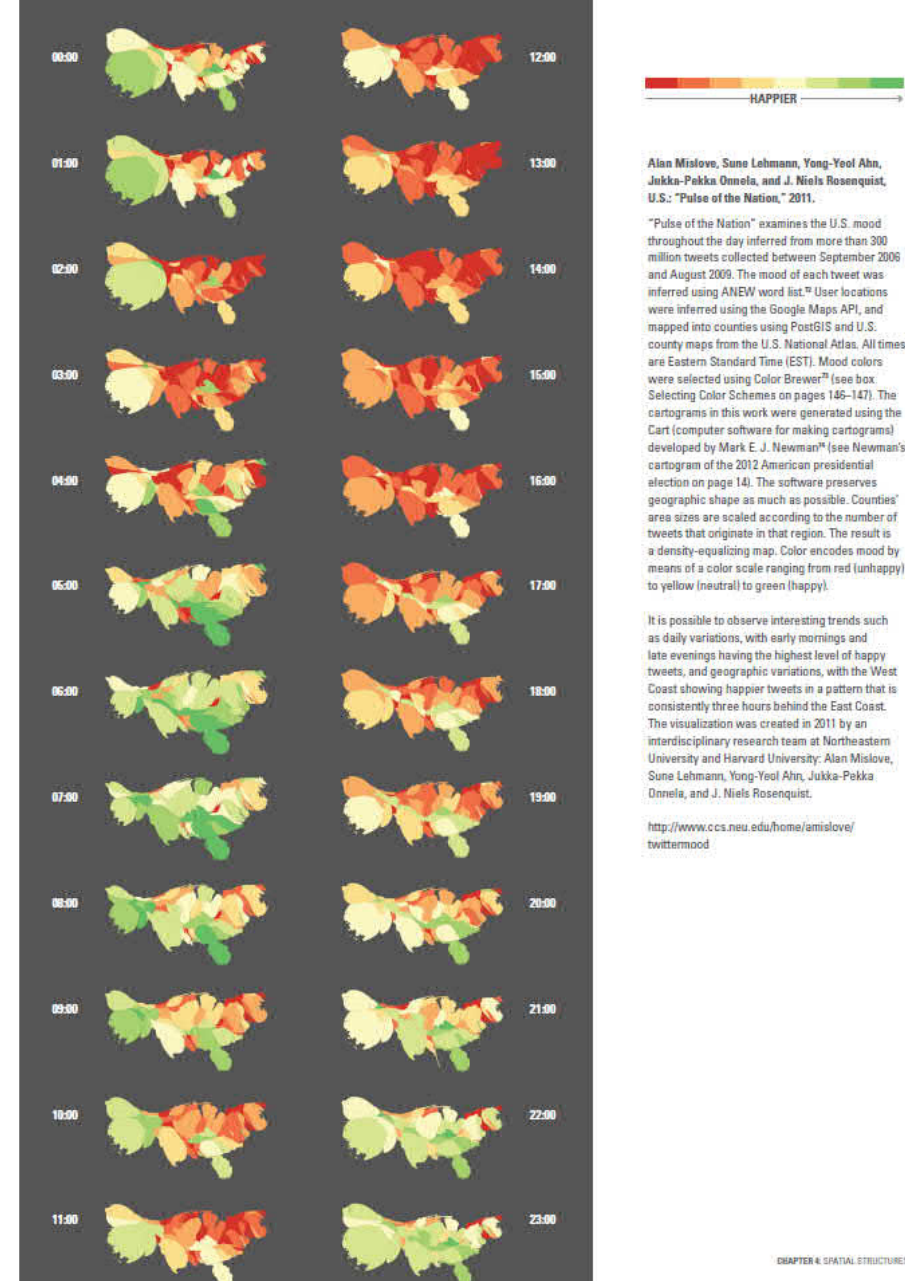
<http://london2012.nytimes.com/results>

Typically, the spatial variables in the map are used to depict space in the world—the continents, countries, counties, and so on. This was the case in all map forms examined thus far. For example, choropleth maps represent thematic data within the boundaries of the given statistical units. As exemplified by the *New York Times* maps, the uncovered political patterns are closely associated with the administrative units used for the symbolization. Strong arguments have been made that for data involving population, such as in social and economic datasets, a topological mapping of space to space is more appropriate.

Area cartograms were devised with this purpose of revealing spatial-geographic patterns. They use the spatial variables in the map for depicting population data according to a thematic variable. To allow identification of the known geographic spaces, most area cartograms make use of algorithms that retain as closely as possible the geographic space in the transformed map space. The "Twitter Mood" cartogram is an example.

Distance cartograms use the relationships in land distance to depict thematic data in the map. The Travel Time Tube Maps by Tom Carden are good examples (see page 168).

There are different ways to render cartograms based on how space is transformed and the extents to which shape, area, and topology are preserved. "Pulse of the Nation" is an example of a contiguous cartogram. It preserves the topology of the map with the area and the shapes loosely retained. The *New York Times* Olympic medal map is an example of a circular noncontiguous cartogram, where original shapes are exchanged for circular shapes.

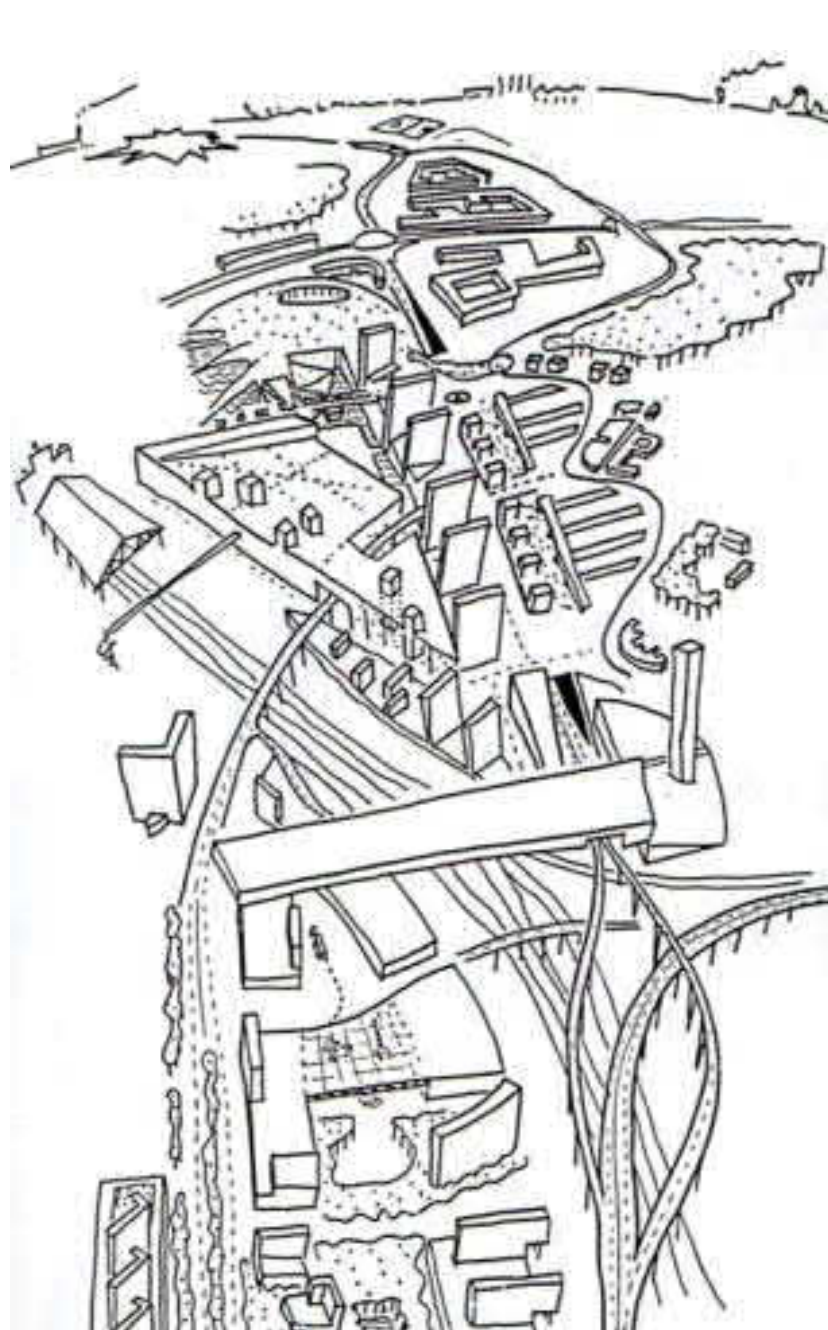
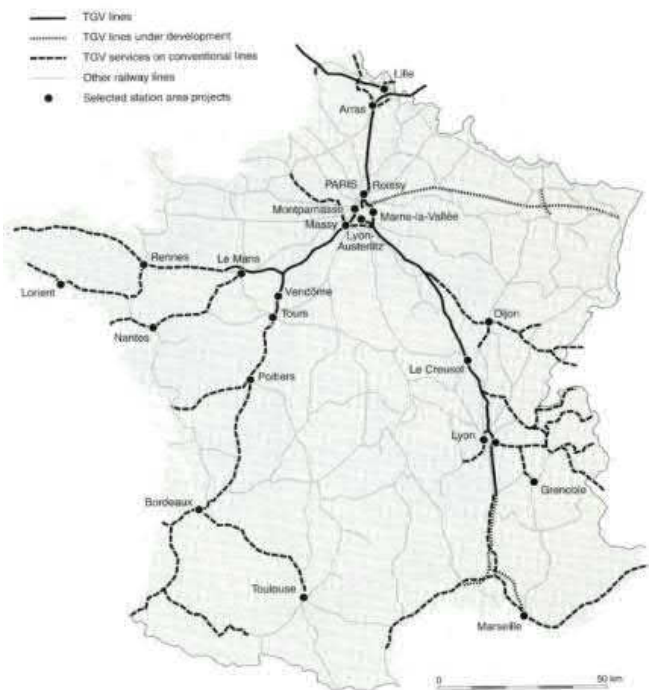


Alan Mislove, Sune Lehmann, Yong-Yeol Ahn,
Jukka-Pekka Onnela, and J. Niels Rosenquist,
U.S.: "Pulse of the Nation," 2011.

"Pulse of the Nation" examines the U.S. mood throughout the day inferred from more than 300 million tweets collected between September 2006 and August 2009. The mood of each tweet was inferred using ANEW word list.²⁹ User locations were inferred using the Google Maps API, and mapped into counties using PostGIS and U.S. county maps from the U.S. National Atlas. All times are Eastern Standard Time (EST). Mood colors were selected using Color Brewer³⁰ (see box Selecting Color Schemes on pages 146–147). The cartograms in this work were generated using the Cart (computer software for making cartograms) developed by Mark E. J. Newman³¹ (see Newman's cartogram of the 2012 American presidential election on page 14). The software preserves geographic shape as much as possible. Counties' area sizes are scaled according to the number of tweets that originate in that region. The result is a density-equalizing map. Color encodes mood by means of a color scale ranging from red (unhappy) to yellow (neutral) to green (happy).

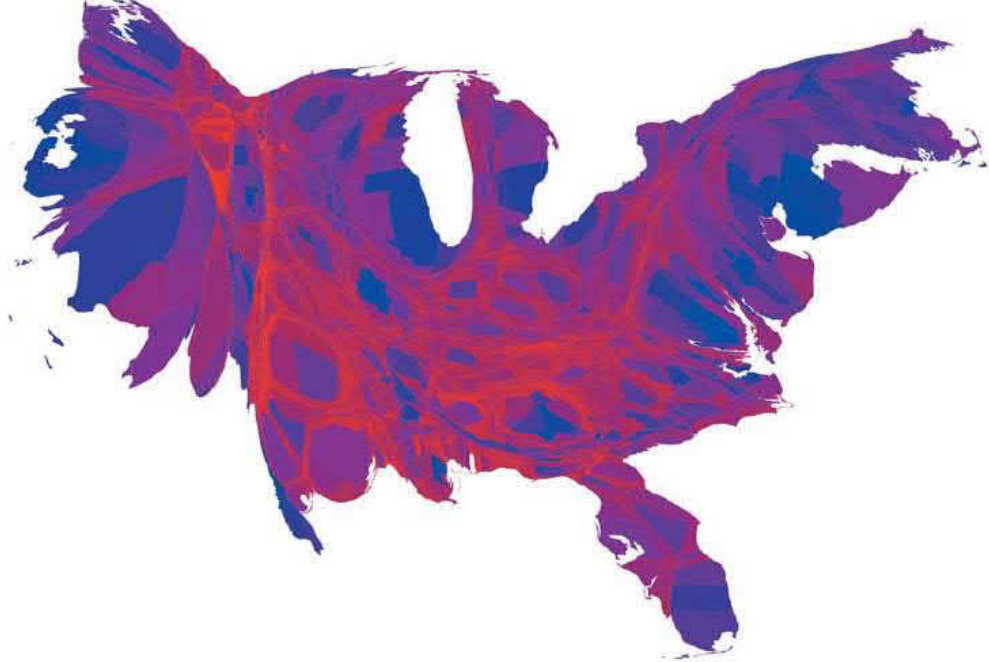
It is possible to observe interesting trends such as daily variations, with early mornings and late evenings having the highest level of happy tweets, and geographic variations, with the West Coast showing happier tweets in a pattern that is consistently three hours behind the East Coast. The visualization was created in 2011 by an interdisciplinary research team at Northeastern University and Harvard University: Alan Mislove, Sune Lehmann, Yong-Yeol Ahn, Jukka-Pekka Onnela, and J. Niels Rosenquist.

<http://www.ccs.neu.edu/home/amislove/twitemood>



Euralille. Lille. 1990-94.
Esquina territorial.

Territorial corner.

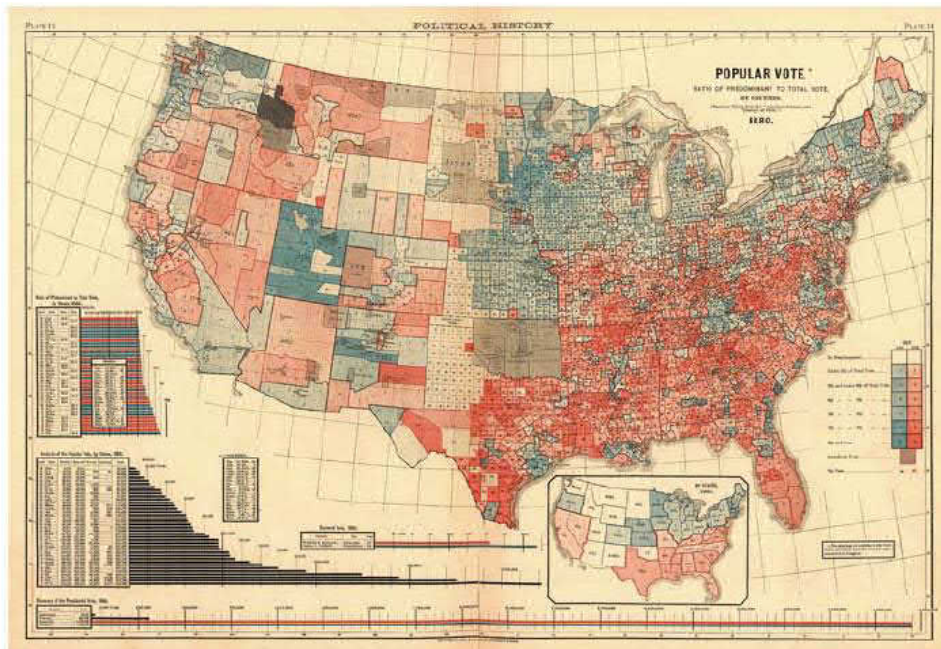


Mark Newman, U.S.: "Presidential Election Cartogram," 2012.

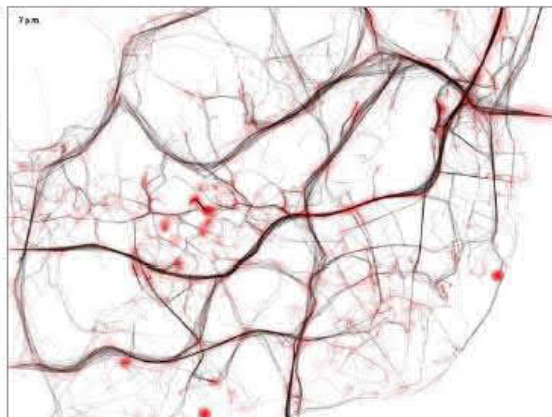
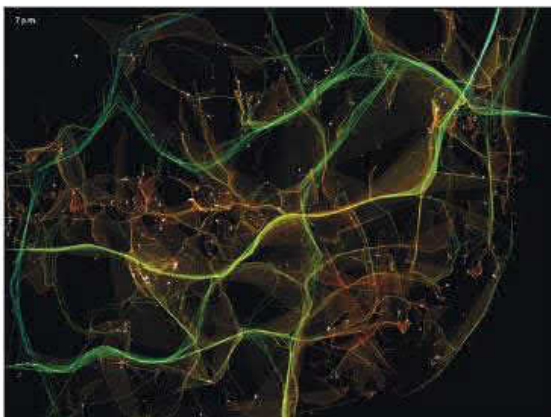
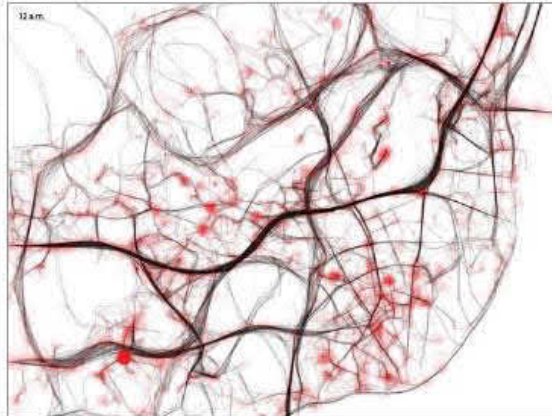
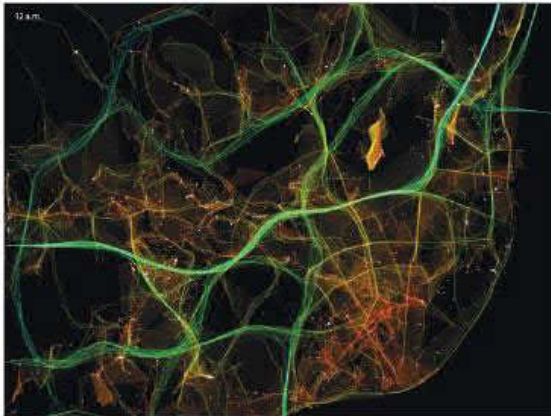
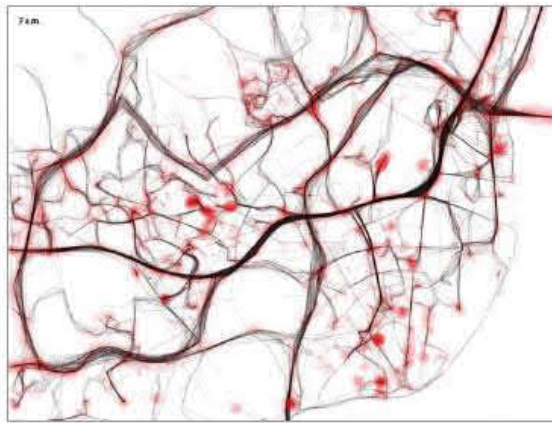
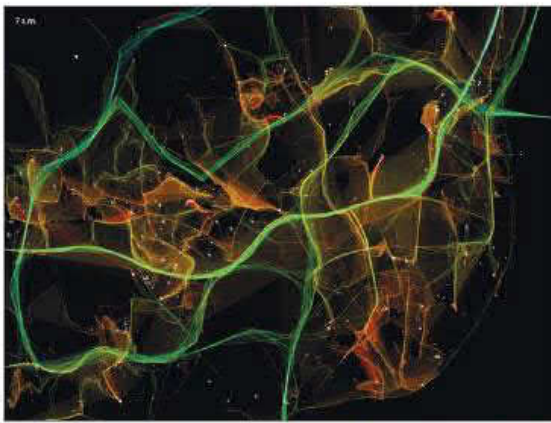
The 2012 presidential election cartogram shows county-level election results, where the sizes of counties are rescaled according to their population. The map uses not just the two party colors, red (Republican) and blue (Democrat), but also shades of purple in between to indicate percentages of votes. The result is a country more evenly divided politically. Mark Newman, Center for the Study of Complex Systems at the University of Michigan, used the diffusion method of Gastner and Newman to make this cartogram.

Fletcher W. Hewes and Henry Gannett, U.S.: *Statistical Atlas of the United States*, 1883.

This map in Scribner's *Statistical Atlas of the United States* shows the popular vote in 1880 mapped according to the ratio of predominant to total vote by counties.



In Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>



estructuras espacio-temporales

SPATIO-TEMPORAL STRUCTURES

Pedro Cruz, Penousal Machado, and João Bicker (University of Coimbra with MIT CityMotion), Portugal: "Traffic in Lisbon," 2010.

"Traffic in Lisbon" is a series of animations of traffic's evolution in Lisbon during a fictitious twenty-four-hour period (from 0.00 to 23.59). The project maps 1,534 vehicles during October 2009 in Lisbon, leaving route trails and condensed into one single (virtual) day. The two sequences are frames from animations exploring different visual metaphors of the city as an organism with circulatory problems.

In the left sequence, recent paths are color coded according to the vehicle's speed: green and cyan for faster vehicles, yellow and red for slower ones. The accumulation of paths emphasizes main arteries, resulting in thicker lines. The right sequence presents the living organism metaphor by depicting slow vehicles as red circles. Cruz explains, "The superimposition of slow vehicles forms solid red clots in the traffic of Lisbon, depicting it as a living organism with circulatory problems."¹⁸

<http://pmcruz.com/information-visualization/traffic-in-lisbon-condensed-in-one-day>

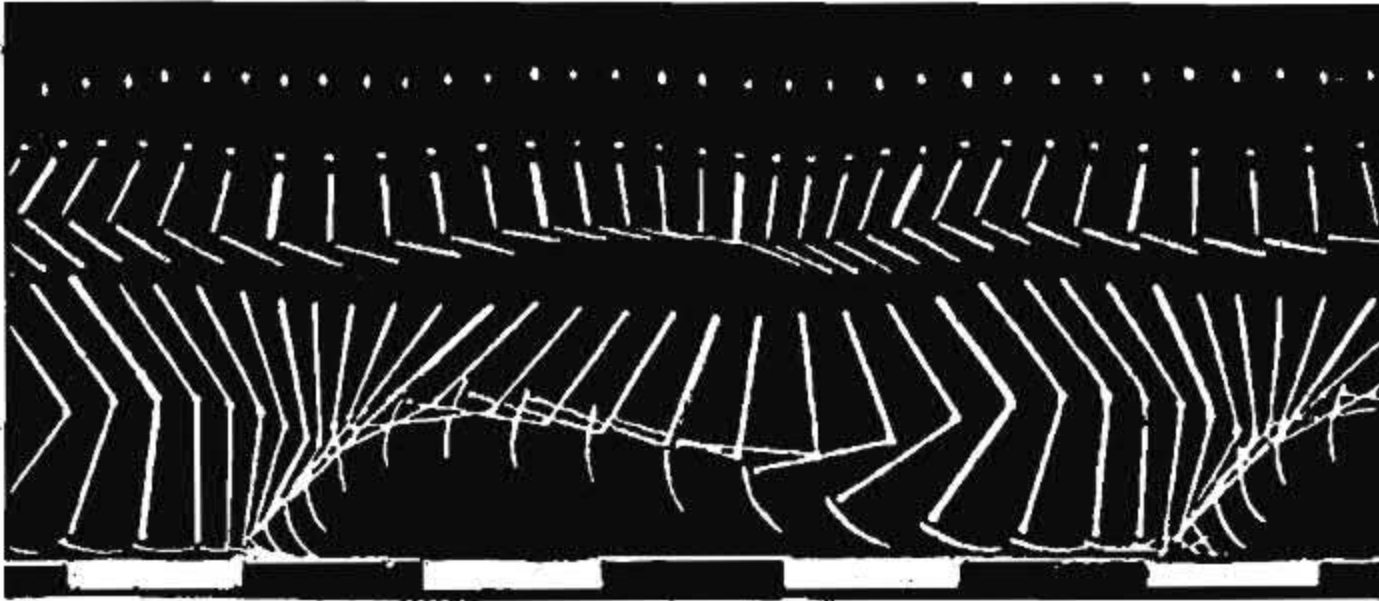
We are surrounded by changes in all dimensions of our existence. All changes require time to become something else, to transform, to remodel, to reorganize, to disappear, and so on. Several fields use time-varying data to understand patterns in natural and social phenomena as well as to help make predictions. Examples range from studies in meteorology and economics to assessment of brain activity.

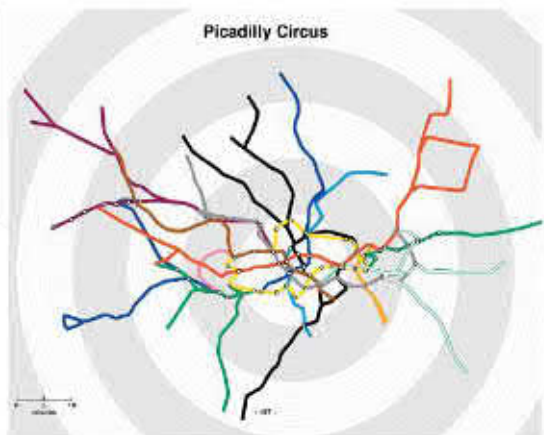
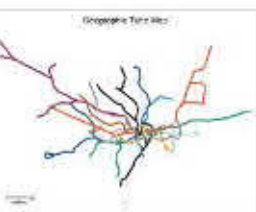
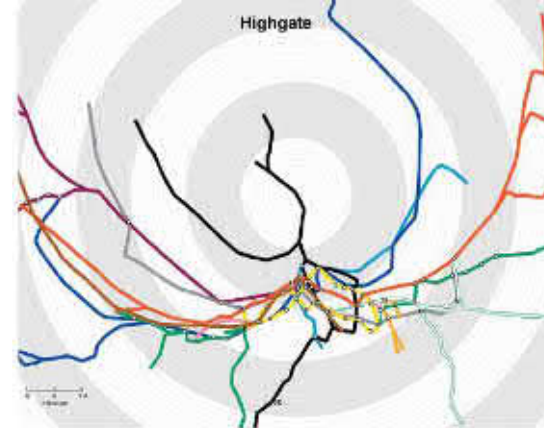
The chapter focuses on spatio-temporal phenomena and processes inherent to the dimensions of space and time. Data belonging to both space and time are found in diverse domains and include mobility, dispersion, proliferation, and diffusion, to mention a few. Our lives are immersed in time and space, and we constantly reason about both, making decisions about where and when we are, were, or will be. From sketches we draw on napkins to give directions to our friends, to more complex cartographic representations of the

In Meirelles, I. (2013). *Design for Information* (Vol. 5).

<http://doi.org/10.1017/CBO9781107415324.004>

Marey's man in black velvet, photographed in stick-figure images, became the time-series forerunner of Marcel Duchamp's *Nude Descending a Staircase*.

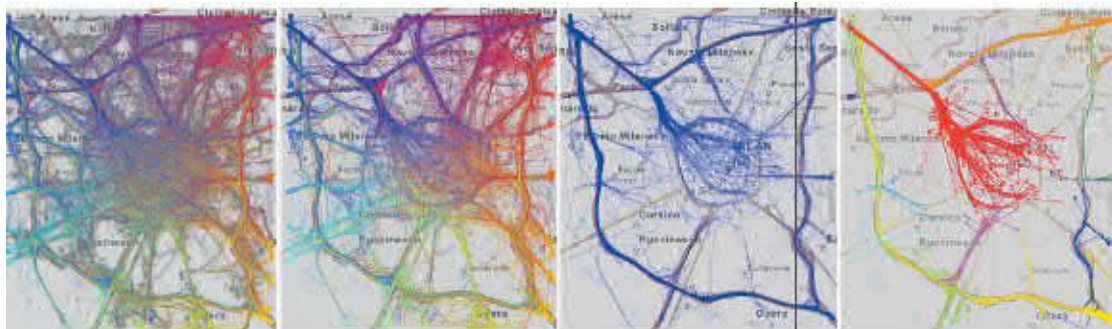




In distance cartograms, a set of concentric circles centered in a specified origin point represents temporal distances, often without a base map, which would be distorted to fit the temporal distances. In other words, it uses temporal distance as a proxy for spatial distance, resulting in distortion of the topology to conform to the temporal measures.

SCALES

Spatio-temporal phenomena exist at different spatial and temporal scales, which significantly affect the extent and amount of detail represented. As seen in chapter 4, maps involve reducing dimensions in order to bring spatial reality to the scale of our human sensory systems. We reduce the three dimensions of space into the two dimensions of maps, and sometimes we reduce even further the three dimensions of space into a one-dimensional element, such as when we represent cities as dots on a map. Similar strategies need to be in place when depicting spatio-temporal phenomena, as MacEachren explains, "Temporally, some geographic space-time processes (e.g., earthquake tremors) are fast enough that we need to slow them down to understand them (as when we 'map' a molecule, cell, or computer chip, for which an increase in scale makes visible a pattern that would otherwise remain hidden).



The image shows the result of clustering by "Common destinations," which compares the spatial positions of the nodes of trajectories. From the 4,284 trajectories, 4,385 clusters are produced (a 81 evenly sized clusters and 2,027 sized as nodes).

In this image, we use the clusters with the color intensity.

The image shows the clusters by size, which considers the length of the trajectory and the number of nodes in the trajectory.

When clustering by "Travel frequency," which considers the number of trajectories that pass through a node, the result is a set of clusters, with the color intensity. The largest cluster is made up of 198 trajectories going from the city center. The next largest cluster is made up of 158 trajectories going from the northwest along the northern railway. The yellow cluster (50 trajectories) depicts trajectories going from the southeast along the railway on the south side of the river.

The image shows the Space-Time Cube (STC) representation of the map. It is a 3D visualization of the data, with the axes representing space, time, and frequency. The STC is a common type of display of a new set of data that uses a three-dimensional space, with two dimensions representing space, and one time. STCs were briefly discussed earlier in the chapter (see pages 161–162).

CLUSTERING TRAJECTORIES

Radakis and Genoudis (2006) explain, "Trajectories of moving objects are quite complex spatio-temporal constructs. Their potentially relevant characteristics include the geometric shape of the path, its position in space, the direction, and the dynamics, i.e. the way in which the spatial location, speed, direction and other point-related properties of the movement change over time. Clustering of trajectories involves applying to a large set of trajectories a technique which can properly deal with their multi-valued properties." To avoid several functions that would make the visualization hard to interpret, the team has developed a method called "progressive clustering." It is a step-by-step process in which the visual representation reduces the clustering by modifying the parameters and applying the new settings. It is a gradual building up of the visualization of the trajectories, with the final image showing the result of progressive clustering in the same visual style as the Map data in the window in the previous page.



Total 2,014 trajectories: 1,004



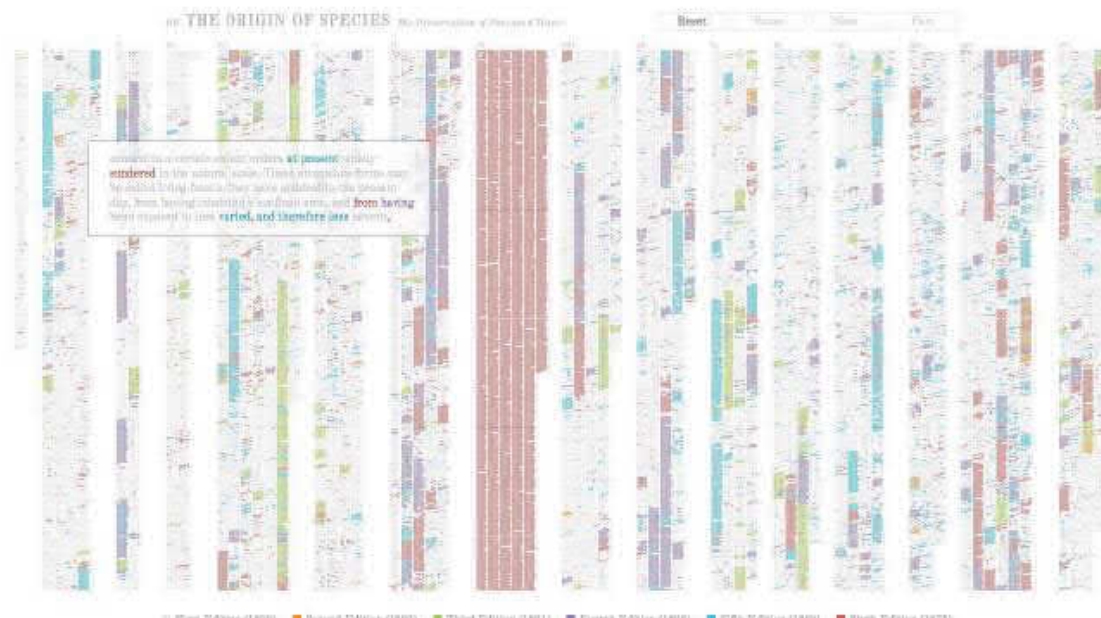
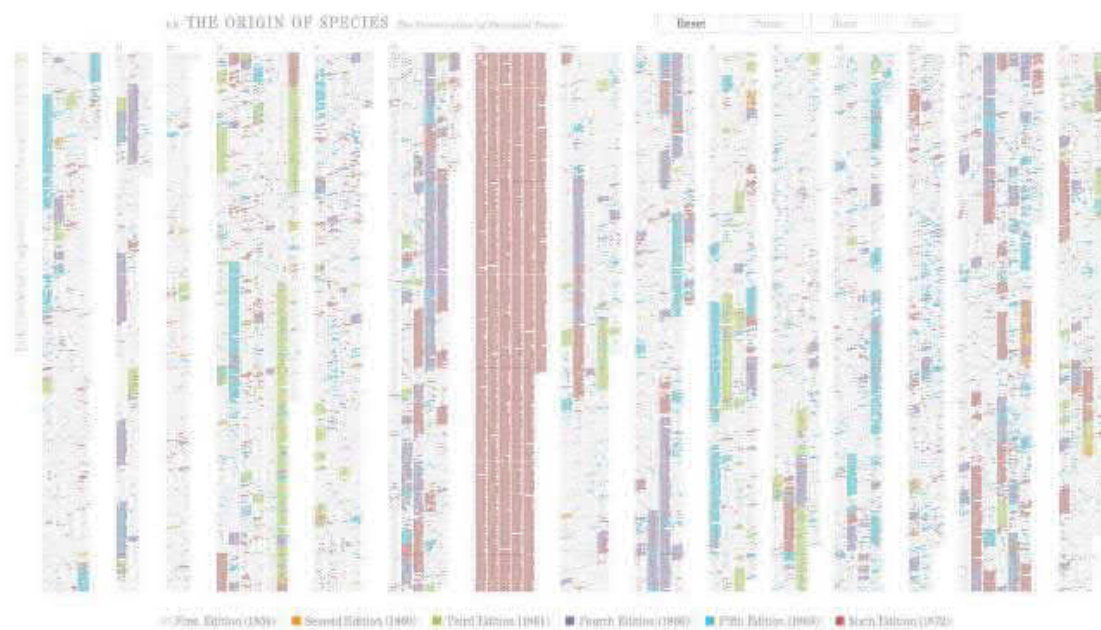
Total 410 trajectories: 204



Total 141 trajectories: 110

BIRD'S EYE VIEW OF MOVEMENT DATA

Visualization and aggregation of trajectories make understanding of the spatial and temporal characteristics of motion movements, which is not possible by looking at individual trajectories. There are different techniques for aggregating movement data, and the most common one is the use of lines of movement, which are formed by points of locations, and these are aggregated into lines. Over the course of the data, and in the visual cluster, Radakis and colleagues have devised a new visualization of the trajectories, which is a bird's eye view of the data, along the path and then aggregating the movement from all trajectories. The result can be viewed in this perspective of the data, showing the shape based on the direction and center for many directions. To distinguish between different directions, each segment is represented by "tail arrow" symbols. The line width is used for magnitudes. Details on the value of aggregation, as well as other time-based data, can be provided by hovering with the supports.



estructuras textuales

TEXTUAL STRUCTURES

Ben Fry, U.S.: "On the *Origin of Species*: The Preservation of Favoured Races," 2009.

The interactive online visualization depicts changes in the six editions of Darwin's *On the Origin of Species*. Each edition is color coded, allowing, for example, at a glance to see how entire volumes were changed over the course of fourteen years. Given the scope of Darwin's work and the limited space we have on the screen, Fry enables one to read text by clicking on the colored blocks. The bottom image shows how the words are also color coded, highlighting changes and refinements in the text over the years. Fry explains, "We often think of scientific ideas, such as Darwin's theory of evolution, as fixed notions that are accepted as finished. In fact, Darwin's *On the Origin of Species* evolved over the course of several editions he wrote, edited, and updated during his lifetime. The first English edition was approximately 150,000 words and the sixth is a much larger 190,000 words. In the changes are refinements and shifts in ideas—whether increasing the weight of a statement, adding details, or even a change in the idea itself."¹⁴ The application was built with Processing, an open source Java-based programming language he developed with collaborator Casey Reas.

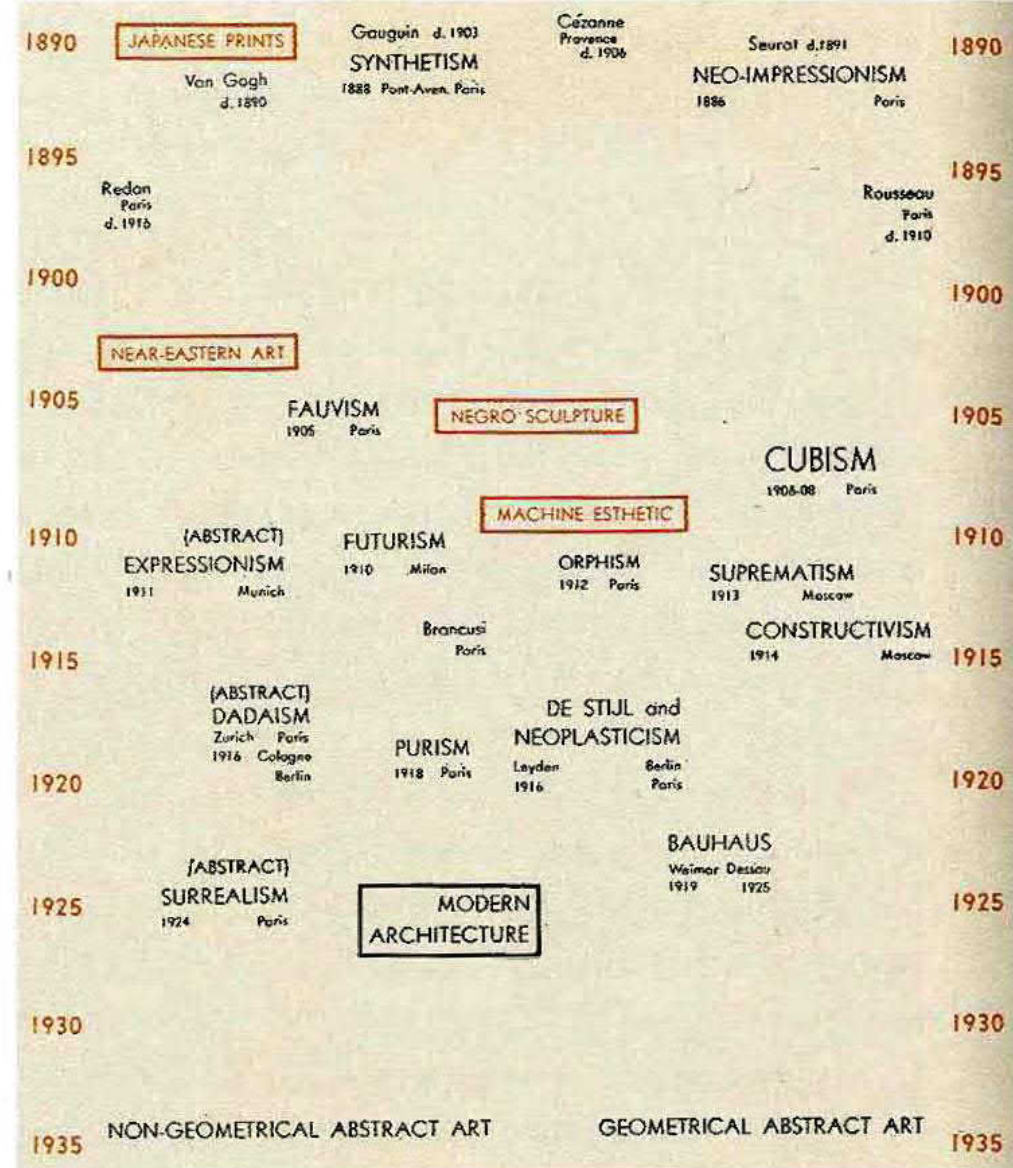
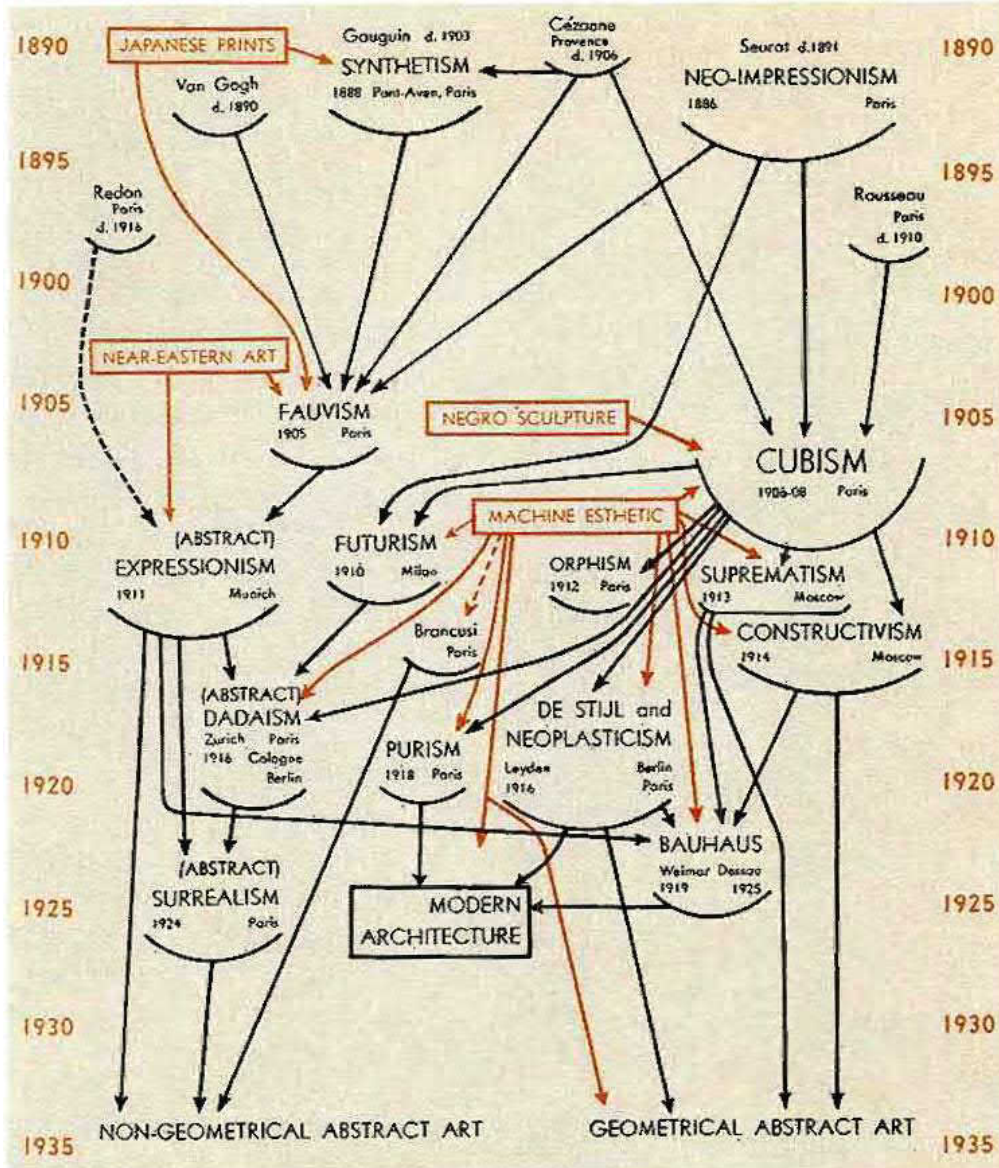
<http://benfry.com/traces>

Recent advances in information storage and computational power have affected and largely facilitated the analysis of natural-language data. Large amounts of historical as well as contemporary documents are available in digital format, opening up new and powerful ways of examining literary data. Furthermore, online social interactions and conversations, mostly textual, are providing new data sources that, coupled with new research questions, are prompting understanding of social phenomena never before possible.

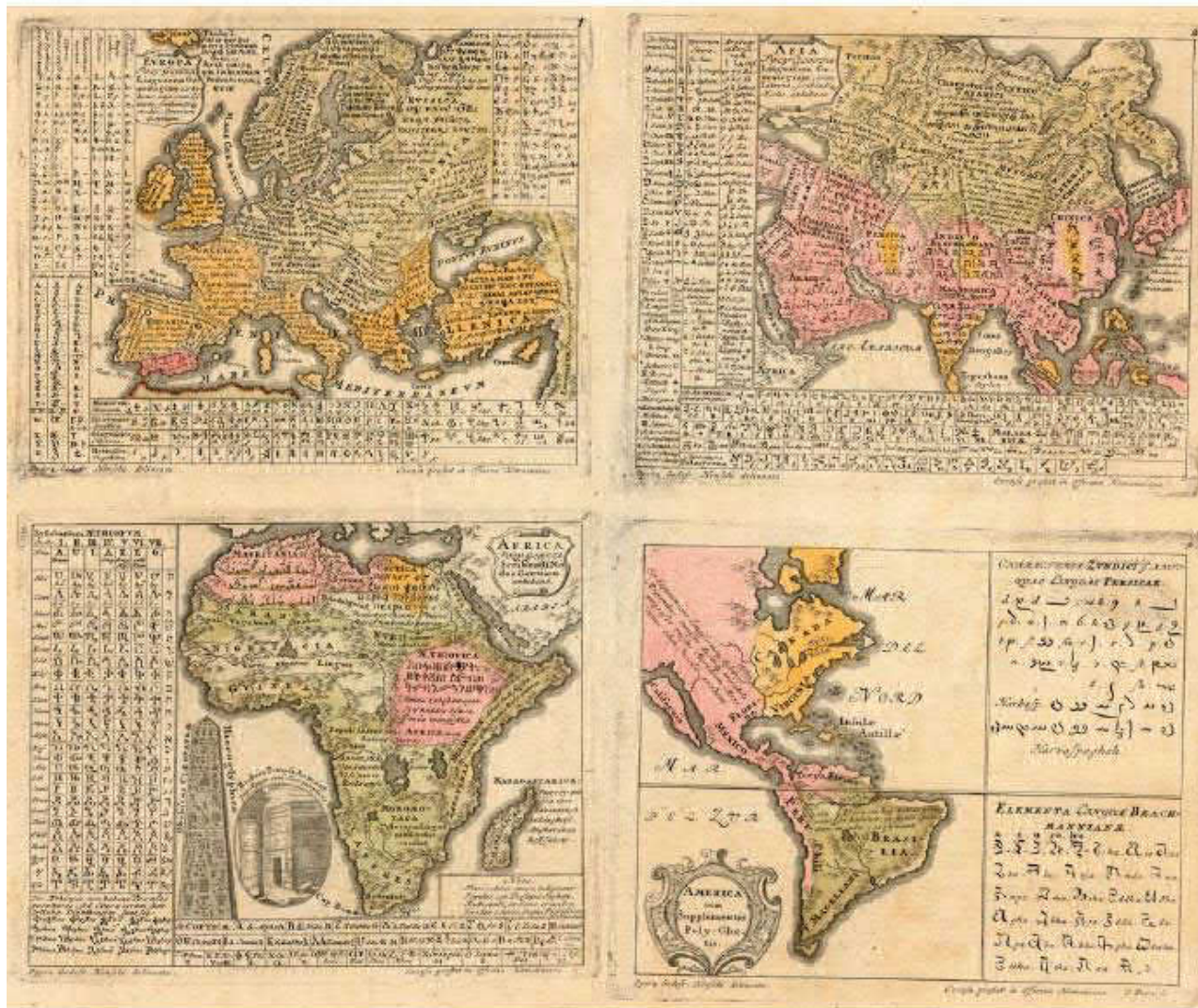
Methods and tools for the visualization of textual data are scarce. Examination of early books on visualization of information, including those by Willard Brinton, Jacques Bertin, and even Edward Tufte, reveal the lacuna. To my knowledge, the first book to dedicate a chapter on document visualization is *Using Vision to Think* by Card

In Meirelles, I. (2013). *Design for Information* (Vol. 5).

<http://doi.org/10.1017/CBO9781107415324.004>



Alfred H. Barr, Jr, *Cubism and Abstract Art* (New York, 1936)



Gottfried Hensel published a series of maps in 1741 in Nürnberg, depicting the use of languages in geographic space. The language usages are demarcated in the map by means of written samples separated by dotted lines. The samples are mostly translations of the first words of the Lord's Prayer into local languages. Robinson speculates that these maps are the first ones to use colors to represent categorical data. He writes, "Hensel's map of Africa uses color to show locations of the descendants of Shem, Ham, and Japheth. His maps may be the first to use color to distinguish areas in a thematic map."¹⁴ The use of colors is explained in the African map on the bottom-right corner as a note in Latin: the colors mark areas settled by descendants of the three sons of Noah: Japhet ("rubicundi," pink), Shem ("oriundos," yellow-orange), and Ham ("virides," olive green).¹⁵

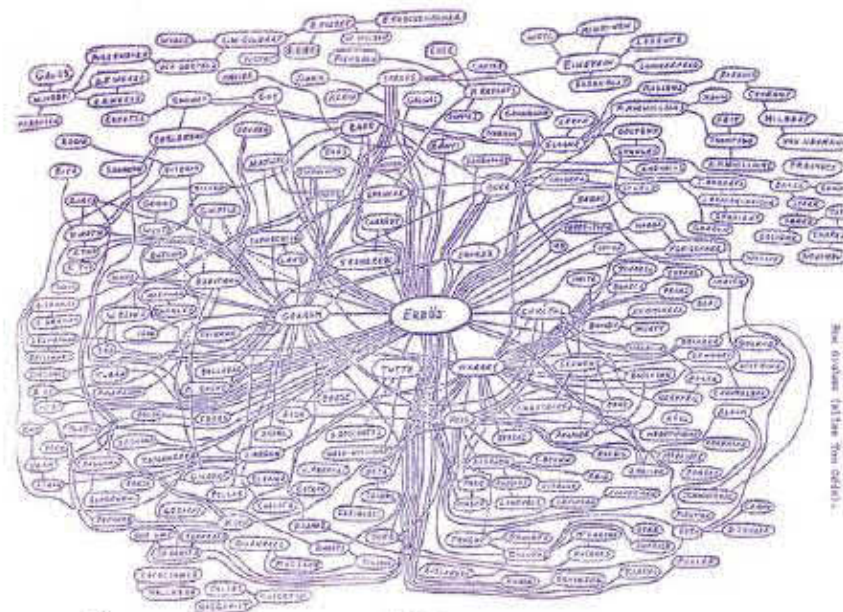


Figure 1. The Erdős network. (Source: Erdős, 1991, p. 100. Reproduced with permission of the publisher.)

Paul Erdős published around 1,500 papers during his prolific career in mathematics, including important contributions to graph theory and random graphs. Ron Graham hand drew this diagram in the 1970s to portray the collaboration network of Erdős. The nodes are mathematicians, and links connect pairs who have jointly authored a paper with Erdős. As Easley and Kleinberg explain, "A mathematician's Erdős number is the distance from him or her to Erdős in this graph. The point is that most mathematicians have Erdős numbers of at most 4 or 5, and—extending the collaboration graph to include co-authorship across all the sciences—most scientists in other fields have Erdős numbers that are comparable or only slightly larger; Albert Einstein's is 2, Enrico Fermi's is 3, Noam Chomsky's and Linus Pauling's are each 4, Francis Crick's and James Watson's are 5 and 6, respectively. The world of science is truly a small one in this sense."¹⁶

In Meirelles, I. (2013). *Design for Information* (Vol. 5).
<http://doi.org/10.1017/CBO9781107415324.004>

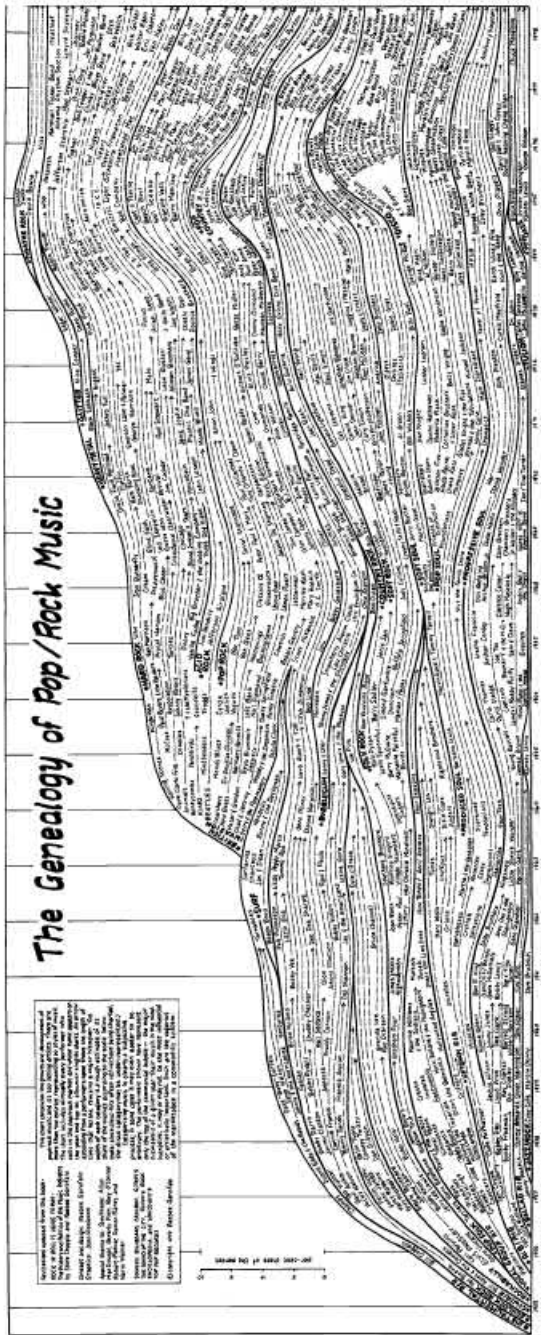


Fig. 2.11: Rock'n'Roll history that depicts protagonists and developments in the area as curved lines that are stacked according to the artists' percentage of annual record sales.
Source: Image courtesy of Reebee Garofalo.

In Aigner, W., Miksch, S., Schumann, H., & Tominski, C. (2016). *Human-Computer Interaction. Encyclopedia of Database Systems*. <http://doi.org/10.1007/978-0-85729-079-3>

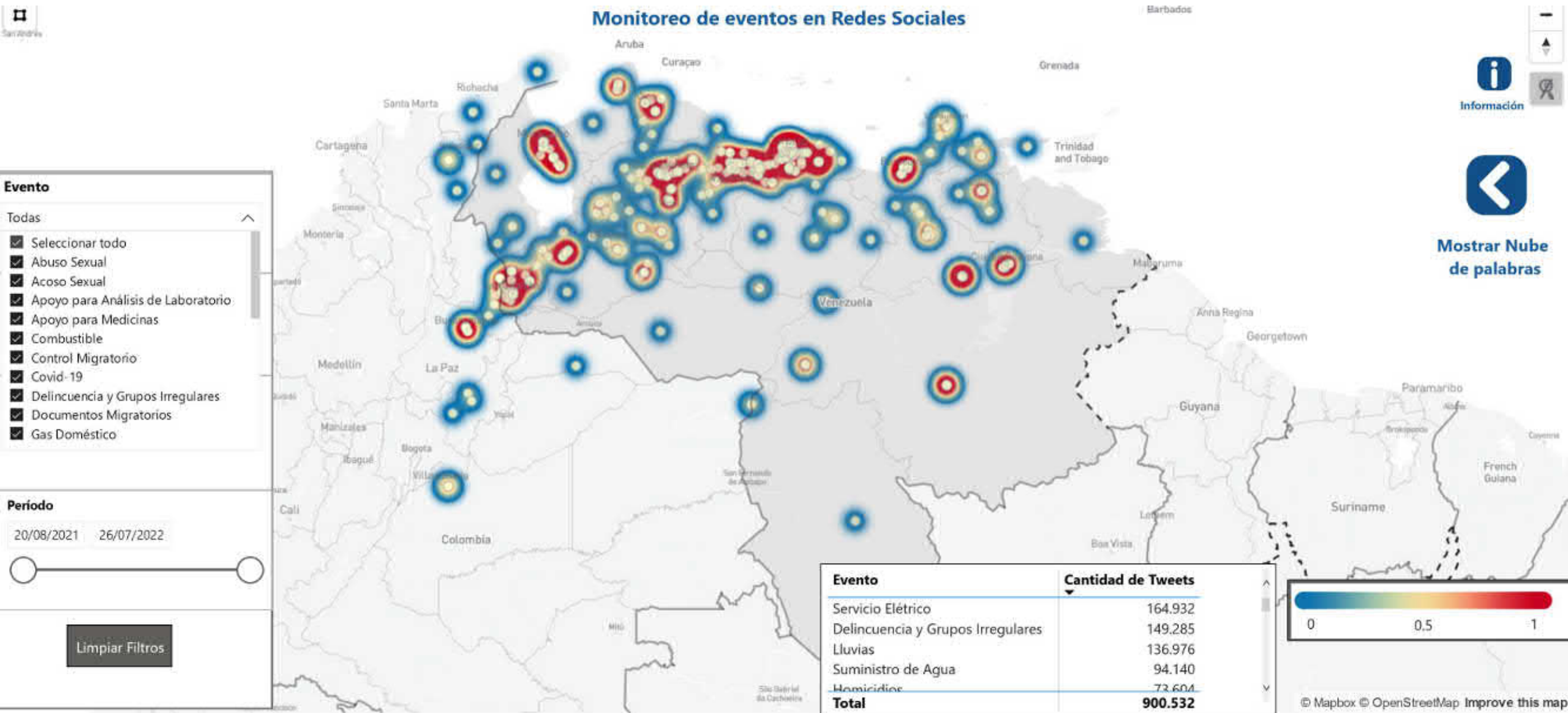
DIGITAL



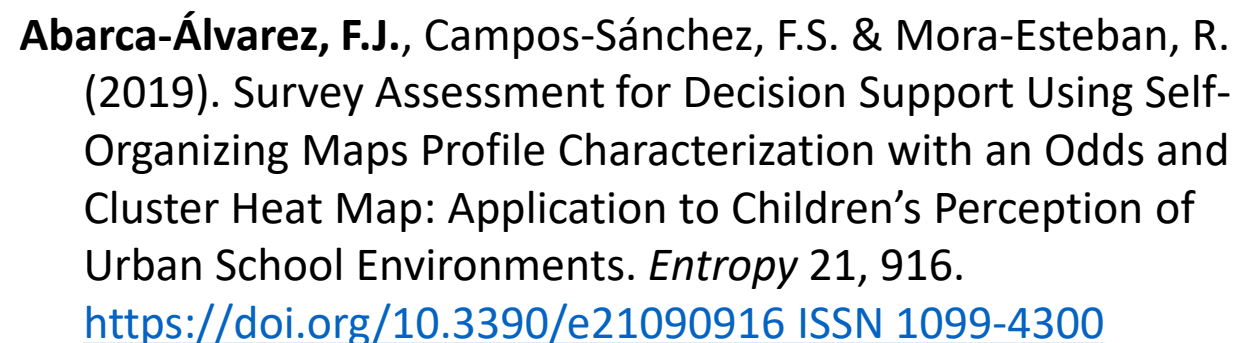
The mindmap is based upon *Mapa conceptual de emprendeduría* first published at <http://www.riunet.es/entrepreneurship/mapa-conceptual-de-la-empresari>

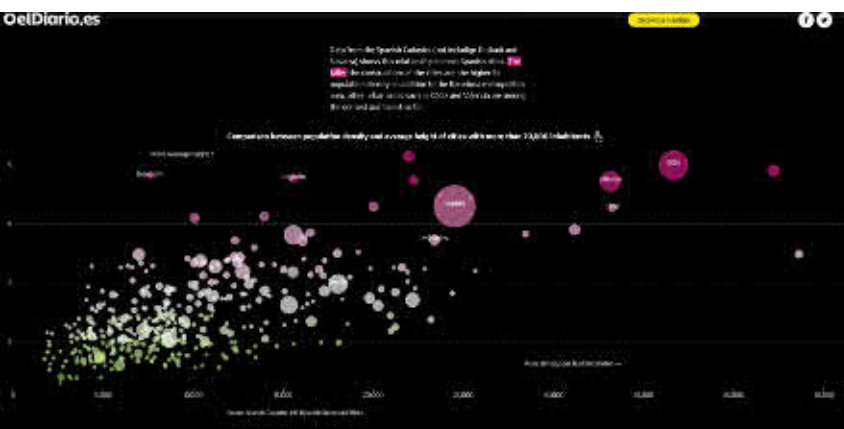
Ecosistema Urbano. Planning for Protest

Things we could learn from #15M in Madrid



GIS4tech (2022) Monitoreo de eventos en Redes Sociales
Social Media Event Monitoring





Storymap: Sánchez, R y Plaza, A. (2022) Spain lives in flats: why we have built our cities vertically. En <https://especiales.eldiario.es/spain-lives-in-flats/>

reflexiones finales

mapa (según Richard Brook y Nick Dunn)

representación que revela un **espacio inédito**

condiciones latentes

narrativas en y de la ciudad

muestra **interpretaciones**

se enfoca en exponer **esencias** del espacio y lugar

al hacerse más **compleja** la realidad social y física

→ las **herramientas** de visualización se hacen más
complejas

Final Thoughts

map (for Richard Brook y Nick Dunn)

a representation that reveals an **unseen space**

latent conditions

narratives in and about the city

presents **interpretations**

focuses on revealing the **essence** of space and place

as social and **physical** reality becomes more complex

visualization **tools** become more complex

reflexiones finales

mapa (según Stan Allen)

acto de comprensión del mundo

diferencian lo importante de lo superfluo

oportunidad de **manipulación inagotable**

los mapas modernos → más que mostrar un orden

→ **muestran procesos**

Final Thoughts

map (for Stan Allen)

an act of understanding the world

distinguishing what is important from what is
superfluous

an inexhaustible **opportunity for manipulation**

modern maps → rather than showing an order

→ they **show processes**

reflexiones finales

mapa (según Kitching et al)

el mapa **no representa el mundo**, ni lo construye

es una **producción constitutiva** entre individuo y mundo

mapas **siempre inacabados**

Final Thoughts

map (for Kitching et al)

The map does **not represent the world**, nor does it construct it

It is a **constitutive production** between the individual and the world

Maps are **always unfinished**

reflexiones finales

mapa (según James Corner)

el mapa **experimenta** con la realidad, **establece conexiones** y

permite **descubrir aquello que todavía no es visible**

calcar reproduce configuraciones ya conocidas

el mapa mantiene **relaciones analógicas** con el territorio (localiza calles, edificios, usos, recorridos, topografía, ...)

+

aproximación **abstracta** basada en decisiones múltiples (encuadre, escala, orientación, proyección, inclusión, etc.)

The map **experiments** with reality, establishes connections, and

allows us to discover **what is not yet visible**

Tracing reproduces already known configurations

Maps maintains **analogical relationships** with the territory (it locates streets, buildings, land uses, topography, etc)

+

an **abstract** approximation based on multiple decisions (framing, scale, orientation, projection, inclusion, etc.)

Final Thoughts

map (for James Corner)

reflexiones finales

mapa (según James Corner)

Cartografiar **es proyectar**

No solo elementos físicos, puede incluir:

- Procesos
- Acontecimientos, actividades económicas o de otro tipo
- Intereses políticos
- Actores sociales
- Usos, prácticas, conflictos, o expectativas

Cartografía

- busca fuerzas latentes
- descubre relaciones
- prepara condiciones

vs

plan

- tiende a fijar un estado futuro
- ordena desde una visión general

Final Thoughts

map (for James Corner)

Mapping is a form of representation

It encompasses not only physical elements, may also include:

- Processes
- Events, economic activities, or other types of activities
- Political interests
- Social actors
- Uses, practices, conflicts, or expectations

Cartography

- seeks out latent strengths
- Discover Relationships
- set the stage

vs

plan

- tends to establish a future state
- order from an Overall View

reflexiones finales

mapa (según James Corner)

Modalidades o prácticas emergentes

- **Deriva** (drift) cartografía la experiencia corporal, contingente y subjetiva del recorrido.
- **Superposición** (layering). Representa separadamente diferentes sistemas y estudia sus interferencias.
- **Tablero de juego** (game-board). Soporte para actores, conflictos, negociaciones y escenarios.
- **Rizoma** (rhizome). Construye redes abiertas, no jerárquicas y con múltiples entradas y conexiones.

Emerging Modalities or Practices

- **Drift**: Maps the bodily, contingent, and subjective experience of the journey.
- **Layering**: Represents different systems separately and studies their interactions.
- **Game board**: A framework for actors, conflicts, negotiations, and scenarios.
- **Rhizome**: It constructs open, non-hierarchical networks with multiple entry points and connections.

Final Thoughts

map (for James Corner)

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