Et pourquoi visualiser si on peut représenter ?

J.Y Blaise, CNRS

This will not be about my own work
Modelling and visualising spatial dynamics:
Reasoning on long time spans and uncertainty
Objective: illustrate through a (subjective) gallery of milestones in what infovis techniques, methods and concepts can be fruitfully applied and/or questioned in the context of the MoDyS thematic school—i.e. when dealing with ill-defined information sets, time, uncertainties, etc.

This is not an overview of infovis or visual analytics as such—far from it

This is not a comprehensive analysis of their legacy (see M.Friendly)

Some epistemological remarks

Et pourquoi visualiser si on peut représenter ?
I shall not picture *infovis* as a box packed with magic wands.

There is a good deal of technology behind contemporary achievements in *infovis* and *visual analytics*.

Yet computation as well as interaction and evaluation aspects will be left aside.

*Timothy O'Brien / visualization of his 1st and 2nd level of connections on the O'Reilly Connection social networking site.*

Timothy M. O'Brien (2005) [http://www.infovis.info/visuals/visualcomplexity/entry52image1.jpg](http://www.infovis.info/visuals/visualcomplexity/entry52image1.jpg)
This diagram shows 15000 photos tagged with the word "sunset", taken throughout 2004. Their horizontal positions represent the day of the year the photo was taken. January is on the left, December is on the right. The vertical bars are the boundaries between months. The vertical position represents the time of day the photo was taken, according to the EXIF data. The horizontal lines are hours, with the thick line in the middle representing 12 noon.

Jim Bumgardner (2005) http://www.infovis.info/visuals/visualcomplexity/entry87image1.jpg

I shall not picture infovis as a box packed with magic wands.

There is a good deal of technology behind contemporary achievements in infovis and visual analytics.

Yet computation as well as interaction and evaluation aspects will be left aside. Mass of data needed will also remain unaddressed.

Et pourquoi visualiser si on peut représenter ?
Instead, an interdisciplinary question: in what can such abstract graphics (or more precisely in what can processes / practices involved in the making of such graphics) help us analyse dynamics of change?

In other words, this is more about modelling issues & visual thinking than about *infovis*
To start with, why should we differentiate representation from visualisation?
Et pourquoi visualiser si on peut représenter ?

Représenter, *i.e.* présenter le résultat d’un processus cognitif, quel que soit son caractère (depuis la description d’un individu jusqu’à celle d’un modèle conceptuel), sous des formes allant de la verbalisation au graphique.

Visualiser, *i.e.* se doter d’outils visuels à caractère abstrait pour faciliter ce processus cognitif, et pour replacer l’observation d’un individu dans un espace informatif en ré-éclairant l’étude.

Representation: displaying results of a cognitive process, using means ranging form verbalisation to graphics

Visualisation: give ourselves means to carry out a cognitive process, and eventually to position a given item inside an information space that may shed a new light on it.
 Representation : displaying results of a cognitive process, using means ranging from verbalisation to graphics.

Visualisation : give ourselves means to carry out a cognitive process, and eventually to position a given item inside an information space that may shed a new light on it.

Et pourquoi visualiser si on peut représenter ?
Et pourquoi visualiser si on peut représenter ?

Representation

~ visualisation ?

Information Visualisation

Capitol in Dougga UMR MAP / De Luca et al. www.map.archi.fr

A. Choisy Histoire de l'Architecture, 1899

Et pourquoi visualiser si on peut représenter ?

Relations could be represented like this.
Et pourquoi visualiser si on peut représenter ?

But are better represented like that

The need
convey some thought

The goal
Systems of signs / audience
/ moment in the analysis

The data
Quantity / type

The design
Families of solutions
The need to convey some thought

The goal: Systems of signs / audience / moment in the analysis

The design: Families of solutions « répertoire des moyens »

representation

language

formalisms  metaphors  models

Et pourquoi visualiser si on peut représenter ?

*Carte figurative*
Charles-Joseph Minard, 1844
The need to convey some thought

The goal: Systems of signs / audience / moment in the analysis

The design: Families of solutions « répertoire des moyens »

representation

communication

formalisms metaphors models

Pie chart
William Playfair 1801

Et pourquoi visualiser si on peut représenter ?
Yet another topic I will not mention: differences between infovis, knowledge visualisation, visual analytics, etc.

What we will be mentioning here is a common legacy, with a focus on “before the computer-age” examples.

Et pourquoi visualiser si on peut représenter ?
Et pourquoi visualiser si on peut représenter ?

outline

1. The legacy : a short introduction, built on M.Friendly’s vision (cartography + statistics)

2. The legacy (2) : when time matters / alternative visions of time-oriented data

3. And now what? Some recommandations, applied to real cases.
According to Michael Friendly, infovis inherits from both cartography and statistics. Let’s find out whether this could be true...
The legacy: cartography & statistics

The map of Bedolina (2000:1000 B.C)
Land divisions with fields, paths, houses and inhabitants.
Mediaeval (~) maps: localise through glyphs, and abstraction (to a certain extent)
The legacy: cartography & statistics

Mediaeval maps: localise and quantify through glyphs, and abstraction (to a certain extent)

This does not show the territory – rivers, castles and houses. It shows information about the territory.

XIVth century onwards: figurative views, villages and hamlets represented with their churches, castles, housing (800 edifices), to serve as evidence before the law.

Source: http://www.cairn.info/resume.php?ID_ARTICLE=RHIS_093_0621
Entre carte, image et pièce juridique : la vue figurée de la baronnie de Sèvérac-le-Château (1504)
Juliette Dumasy
The legacy: cartography & statistics

A move towards more exactness (not necessarily towards more information)

Carte de Cassini

Surveys between 1756 and 1789
Published between 1756 and 1815.

http://fr.wikipedia.org/wiki/Fr%C3%A9jus
The legacy: cartography & statistics

A move towards more exactness (not necessarily towards more information) with exceptions, though

A XVIIth c. anonymous map showing the agricultural, mining and manufacturing activities of each of France’s Provinces
The legacy: cartography & statistics

The first visual representation of statistical data

12 knows estimates of the difference in longitude between Toledo and Rome

(1644, M.F Van Langren)

* M. Friendly A brief history of data visualisation
A move towards (yet more) abstraction

**Tableau poléométrique**  
Charles de Fourcroy 1782

Use of geometric, proportional figures (squares) to compare demographic quantities by superposition, an early "tableau graphique"
The legacy: cartography & statistics

And many other inventions during the XIXth century

**Statistical chart**
William Playfair 1801
http://www.datavis.ca

**Polar-area charts**
André Michel Guerry 1829
Polar-area charts (predating those by Florence Nightingale, showing frequency of events for cyclic phenomena
http://www.datavis.ca

**Star plot**
Georg von Mayr, 1877
http://datavis.ca/milestones/admin/uploads/images/vonmayr2.gif
The legacy: cartography & statistics

Rectangle, circles, and now lines

1838 print by Heinrich Berghaus (1797-1884), Germany

Physical atlas of the distribution of plants, animals, climate, etc., one of the most extensive and detailed thematic atlases; most of the maps contained tables, graphs, pictorial profiles of distributions over altitude, and other visual accompaniments.

Tableau figuratif
Charles-Joseph Minard, 1844

``Tableau-graphique'' showing transportation of commercial traffic by variable-width (distance), divided bars (height ~ amount), area ~ cost of transport [An early form of the mosaic plot].-

http://euclid.psych.yorku.ca/SCS/Gallery/milestone/sec5.html
The legacy: cartography & statistics

And now both cartography and statistics

Cartogram, map with shadings from black to white (distribution and intensity of illiteracy in France), the first (unclassed) choropleth map, and perhaps the first modern statistical map.

The legacy: cartography & statistics

And now both cartography and statistics

Verlag von B.G. Teubner, Leipzig, 1925.
The legacy: cartography & statistics

Flow maps

Minard’s figurative maps. Charles-Joseph Minard, 1865
The legacy (2) : when time matters

One step beyond towards (and Minard again) : flow maps showing quantities over time

Charles-Joseph Minard, 1869

Defies the pen of the historian by its brutal eloquence

« nulle part la marche des armées n’atteint ce degré de brutale eloquence qui semble défier la plume de historien »
E.J Marey La méthode graphique dans les sciences expérimentales, 1878

In this second part again, a quick and subjective overview of some key Time – oriented data visualisation

Back to the origin of time-oriented data visualisation: timelines

Time represented as a continuum, read from left to right,
symbols added to type the information (here character / profession).

Durations represented by bars.

**Carte chronologique**
Jacques Barbeu-Dubourg 1753

An annotated timeline of history (from Creation) on a 54-foot scroll, including names and descriptive events, grouped thematically, with symbols denoting character (martyr, tyrant, heretic, noble, upright, etc.) and profession (painter, theologian, musician, monk, etc.)

**Historical timeline**
Joseph Priestley, 1765
http://euclid.psych.yorku.ca/SCS/Gallery/images/priestley.gif

Life spans of 2,000 famous people, 1200 B.C. to 1750 A.D.), quantitative comparison by means of bars

From www.datavis.ca
The legacy (2) : when time matters

Back to the origin of time-oriented data visualisation: timelines

Google TimeMap

A still dominant vision of time.

Helps segregating more than it helps comparing

Helps comparing more than it helps gaining a global view on a collection

WikiTimeScale

Simile
The legacy (2) : when time matters

1. Timelines, timecharts, and related :

Adding quantities / combining time points and time intervals

The ThemeRiver™ visualization helps users identify time-related patterns, trends, and relationships across a large collection of documents.

Theme river
http://vis.pnnl.gov/research_themeriver.stm
Voir aussi :
http://www.ifs.tuwien.ac.at/~silvia/wien/vu-infovis/references/havre-ieeefonvis00.pdf

Multivariate historical timeline

N.Davies, Europe: A history, Pimlico 1997
The legacy (2) : when time matters

2. Galton’s multivariate weather charts :

Time seen as discrete – introduces granularity

**Small multiples**

Francis Galton, pub. 1863.
in M.Friendly, *A Brief History of Data Visualization*

Multivariate weather charts, arranges as small multiples
The legacy (2) : when time matters

Day

Barometric pressure
Wind and rain
Temperature

Small multiples
Francis Galton, pub. 1863.
in M.Friendly, A Brief History of Data Visualization
Multivariate weather charts, arranges as small multiples
The legacy (2): when time matters

Analysis of weather patterns across Europe (Galton, pub. 1863).

Low pressures (black, first part of the month): CCW wind direction.
High pressures: CW wind direction.

“anti-cyclonic” (anticlockwise) pattern of winds around low-pressure regions, combined with clockwise rotations around high-pressure zones.

Small multiples
Francis Galton, pub. 1863.
in M.Friendly, A Brief History of Data Visualization
Multivariate weather charts, arranges as small multiples

observations on barometric pressure, wind direction, rain and temperature December 1861
3. Marey’s train schedule

The legacy (2): when time matters

Train schedule
E.J. Marey 1885

E.R Tufte The visual display of quantitative information,
Graphic Press, Cheshire 2001
Angle = speed

3. Marey’s train schedule

E.J. Marey 1885

The legacy (2) : when time matters

3. Marey’s train schedule

Train to train comparisons

all trains

each train
The legacy (2) : when time matters

About each train:
- Durations of stopovers for each train
- Amount of stopovers for each train
- Number of stations on the route
Trains 2 and 3 travel at approx. the same speed
Train 1 is the slowest
Until the "Les Laumes" station (where can this be, I wonder), trains 3 et 4 travel at approx. the same speed. From then on difference in speed increases.

Train to train comparisons:
The legacy (2) : when time matters

Influence of the number of stopovers on the travel time
Densities of departure and arrivals throughout the 24 hours.
Night trains / day trains speed comparisons available

About all trains:
The legacy (2) : when time matters

About all trains:

The number of stopovers does not justify differences in speed (train 2 five stopovers, train 3 six stopovers yet train 3 faster than train 2)
The fastest trains (both ways) leave at the same time of day

...
The legacy (2) : when time matters

4. Cyclic time : the origin

Depicting periodic behaviours

Cyclic time: an old concept, used in many calendars – cycles may be represented in combination with linear time

http://en.wikipedia.org/wiki/Ouroboros

Joseph Mede’s *Key of the Revelation* from Latin into English in 164, maps the end of history onto a complex graphical figure combining cyclical and linear forms.

Issue 13 Futures Spring 2004
A Timeline of Timelines
Sasha Archibald and Daniel Rosenberg
1627

http://www.cabinetmagazine.org/issues/13/timelines.php
The legacy (2) : when time matters

4. Cyclic time : the origin

Depicting periodic behaviours
The legacy (2): when time matters

4. Cyclic time: treemap (non-polar) visualisation

Depicting periodic behaviours
The legacy (2) : when time matters

4. Cyclic time : Spiral Graph

Visual representations of a time-oriented dataset describing the number of influenza cases over a period of three years – left: SpiralGraph encoding 27 days per cycle (improperly parameterized – periodic pattern is hard to see) right: SpiralGraph encoding 28 days per cycle (properly parameterized – periodic pattern stands out).

Spiral graph
http://www.informatik.uni-rostock.de/~ct/pub_files/Aigner08TimeVis.pdf
Visual Methods for Analyzing Time-Oriented Data
W.Aigner, S.Miksch, W.Müller, H.Schumann, and C.Tominski
The legacy (2) : when time matters

1. Timelines, timecharts, and related : Linear time, combining time points and time intervals, showing quantities

2. Galton’s multivariate weather charts : Time seen as discrete – introduces granularity

3. Marey’s train schedule
   Adding speed / frequency / context+ focus reading

4. Cyclic time
   Depicting periodic behaviours

Four fundamentally different designs, because each of these visualisations explores/considers a different aspect of the time variable.
The legacy (2) : when time matters

Linear time, time points / time intervals

Discrete time /
Granularity and resolution

Duration / frequency
Anchored / non anchored time

Cycles

See “Visualization of time-oriented data”
From this legacy at least two observations on the visualisation of time-oriented data:

Because there are alternative visions of time-oriented data, or different aspects of the time variable needing investigation, it is likely that we shall need alternative visualisations

There are good solutions: when Tufte redraws Marey he changes ... the width of a couple of lines.
Cartography & statistics > infovis

Maybe in « drawing techniques » or in « graphic variables » , but also in the way one should design and use graphics, i.e. a legacy in terms of methods

Levasseur – cartographie /statistique graphique (1885)
“il faut disposer [ce qu’on met sur un diagramme] de manière que l’œil saisisse tout d’abord l’ensemble avec netteté et que l’esprit pénètre ensuite sans effort jusqu’à la notion de détails”

“One should display [contents] so that the eye first catches the overall picture with clarity, and then so that the mind enters without effort down to details”.

B.Scheidermann – Infovis, turn of the XXIst century
“overview first, details on demand”
*Graphical excellence* exists.

It is **not a matter of technology**. Computer-based tools do not *create* graphical excellence.

It often meets Maeda’s laws of *simplicity*.

Computer-based solutions offer *new opportunities*, that should not stray us from seeking graphical excellence.

* E.R Tufte *The visual display of quantitative information*, Graphic Press, Cheshire 2001

J. Maeda. *No simplicity without complexity*, In G.Schuller, *Designing universal knowledge*, Lars Muller Publisher 2008
3. And now what? Some recommandations, applied to real cases.

**Rule 1 : Enforce comparisons within the eyespan**

*E.R Tufte The visual display of quantitative information*, Graphic Press, Cheshire 2001
3. And now what (2)

3. And now what (2)


**Chronologie**

<table>
<thead>
<tr>
<th>Vᵉ-XIIᵉ siècle</th>
<th>XIIIᵉ-XVᵉ siècle</th>
<th>XIXᵉ-XXᵉ siècle</th>
</tr>
</thead>
</table>


Not easy comparing left and right page, reading densities of points and intervals, differences in terms of intervals, granularity, doubts, etc…

Could some simple visualisation help shedding a new light on this data
Clues about various parts of the episcopal group
Clues about various parts of the episcopal group

Clues verbalised in different ways

Early middle ages According to wikipedia:

Le haut Moyen Âge débute à la fin du Ve siècle [réf. nécessaire] et s’écoule jusqu’à la fin du IXe siècle.

Last quarter of the XIlth century : 24 ? 25 ? 26?

Indication are different, and both leave space for interpretation
3. And now what (2)

**Clues about various parts of the episcopal group**

Not that many clues, not that many parts: the simpler the better.
Rule 2: Graphic representations relating to numbers should be directly proportional to the quantities represented;
3. And now what (2)
Granularity (as observed in the text)

$\frac{1}{4}$ century
3. And now what (2)

\[ \frac{1}{2} \text{ century} \]

Granularity (as observed in the text)
3. And now what (2)

Granularity (as observed in the text)
3. And now what (2)

Granularity (as observed in the text)
Open intervals

3. And now what (2)
3. And now what (2)

Between a and b
3. And now what (2)

Around / approximately (etc.)
3. And now what (2)

Dating, trend, duration

Granularity

Open intervals

Between a and b

Beginning of / end of

Around / approximately (etc.)
Rule 3 do not show data out of context.
Rule 1: Enforce comparisons within the eyespan

3. And now what (2)

- Dating, trend, duration
- Granularity
- Open intervals
- Between a and b
- Beginning of / end of
- Around / approximately (etc.)
3. And now what (2)

Dating, trend, duration

Granularity

Open intervals

Between a and b

Beginning of / end of

Around / approximately (etc.)
Rule 4: Overview first, details on demand

- Dating, trend, duration
- Granularity
- Open intervals
- Between a and b
- Beginning of / end of
- Around / approximately (etc.)
Rule 5: Data/ink ratio principle

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.
Granularity

Open intervals

Between a and b

Beginning of / end of

Around / approximately (etc.)

Dating, trend, duration
encourage the eye to compare the data;
*What do we see – overview first*
What do we see – granularity on demand
« De tous les éléments de l’ensemble cathédral, le palais épiscopal est le moins bien conservé […] il faut se résigner à ignorer à peu près tout d’un édifice dont seuls l’existence et l’emplacement sont avérés »

« among all the elements of the cathedral ensemble, the episcopal palace is the least well preserved. […] one has to accept ignoring almost ever said ie that it existed and where

What do we see – an outlier
« La sacristie existait déjà à la fin du XIIIème siècle. Sa réfection date probablement du premier tiers (etc.) »

« … existed at the end of the XIIIth c. Its repair probably dates from (etc.) »
The visualisation did help spotting some indications (not that obvious from reading the text)
Above all with this little « par l’absurde » demonstration proves – or helps understanding - through visual means that the proposed chronology tells just another story than the book…

(Most likely with very good reasons)

The reader could have imagined it as an outline of the book. It is not.

And this is one of the services visual thinking can offer in the context of long time spans, and poor data sets: analyse our own work, have ourselves face what we say, re-read our data and spot where we over-interpreted it.
Handling uncertainty: a modelling issue first, a visualisation issue too

3 open challenges:
• Classifications
• Qualifying / quantifying
• Visualisation

Classifications exist, main categories introduced can be of use across disciplines, although it is likely that they will need to be adapted / extended for this or that specific problem – in particular in historic sciences.

Conclusion

However when it comes to qualifying/quantifying, things get tougher.

Accuracy/error : Difference between observation and reality.
Sub-categories :

- Collection Accuracy
- Processing errors
- Deception

- A report may note that 50 tanks were observed although the tanks may in fact be dummy placements.

D’authentiques historiens qui, par la suite, relateront [ce récit miraculeux] dans des textes souvent succincts, quelquefois romancés, mais toujours empreints d’une grande conviction.

At the end of the day factors of uncertainty are most often weighed through discrete (numerical or lexical) scales that introduce yet another uncertainty.
Handling uncertainty: primarily a modelling issue

In short there are many factors contributing to uncertainty, as shown by existing classification efforts.

It seems that as soon as we wish to qualify/quantify the doubt, and ultimately visualise it, means and solutions that we can rely on in order to convey the information’s complexity (i.e. uncertainty) tend to shrink.

Accordingly, we believe it is necessary to address the 3 issues at a time - classifying, qualifying/quantifying, visualising – otherwise we find ourselves commenting uncertainty, rather than analysing it.

This is the reason why this thematic school’s programme encompasses modelling and visualisation steps.
Infovis as a discipline is not necessarily directly and/or fully applicable to ill-sourced dynamics: too weak data sets

However even in the context of historic sciences, on long time spans, it can be profitable to take inspiration from the modelling, data structuring, visual reasoning and evaluation efforts in use in that discipline.

So, infovis and its outgrowths, yes, when possible. But if not, at least some visualisation effort can help the analyst. XIXth c. key milestones show that even without the support of contemporary computer tools insight on a time+space related problems can be gained by an appropriate visualisation effort.

And because the tools we use to produce graphics have changes over time, the afternoon lectures focus on computer graphics.
Thank you

and maybe

Ooops sorry (means I did not finish on time)