

CNAM - Département Informatique

RCP216 Ingénierie de la fouille et de la visualisation de données massives

Visualisation d'information (3)

Représentations multidimensionnelles

Pierre Cubaud <cubaud@cnam.fr>

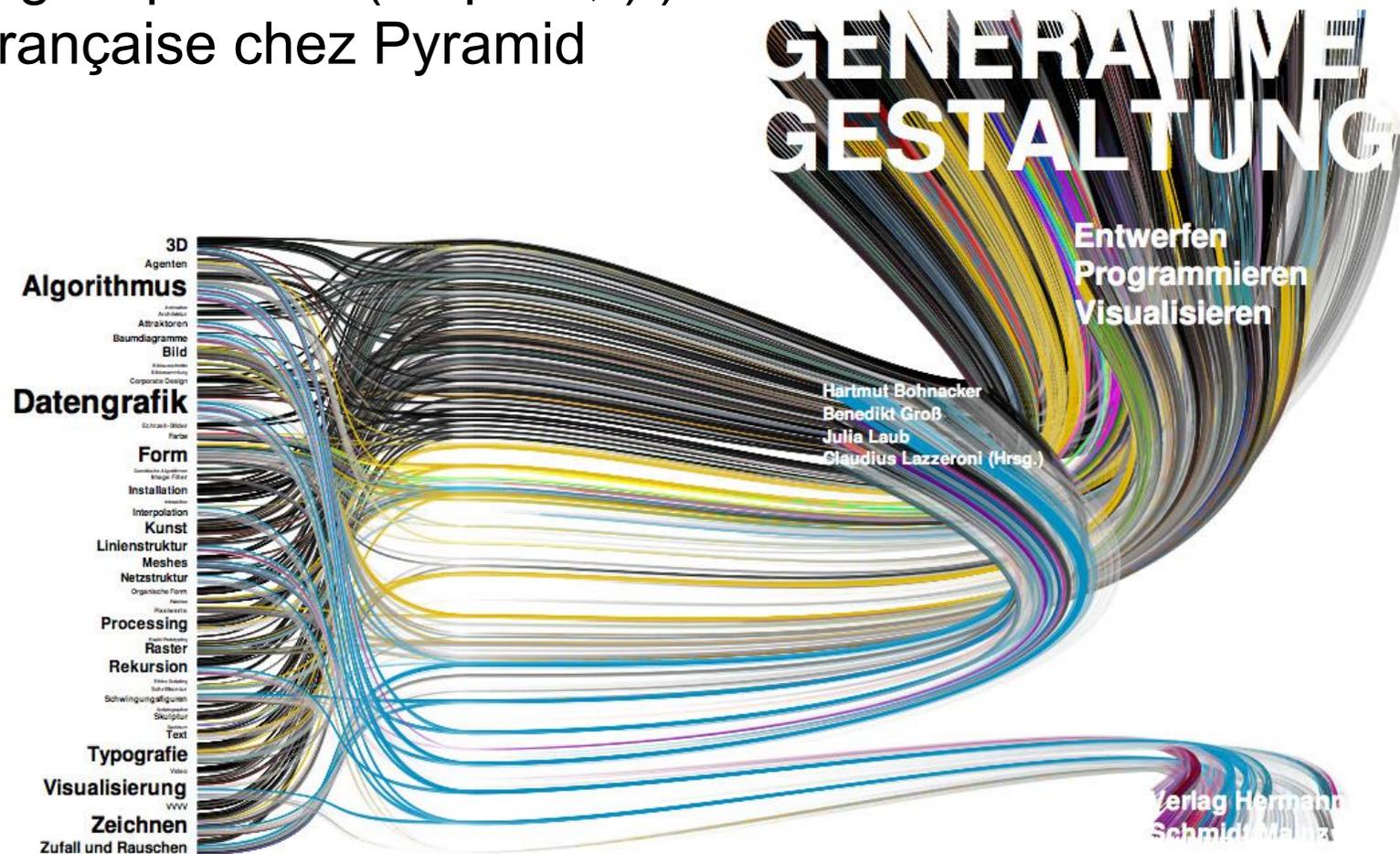
mai 2015

le **cnam**

Plan de l'exposé

1. de la 1D à la nD et aux graphes
2. Petits multiples
3. Les arbres
4. Les graphes généraux

Un magnifique livre (de plus ;-)
trad. française chez Pyramid



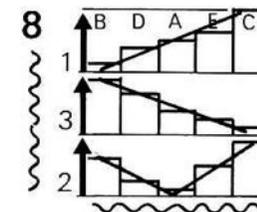
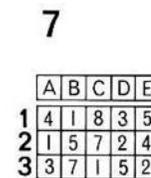
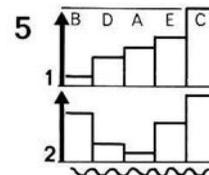
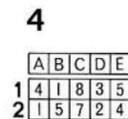
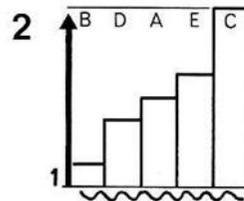
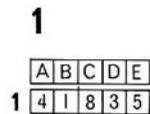
tous les codes du livre : <http://www.art-generatif.com/>

1. De la 1D à la nD

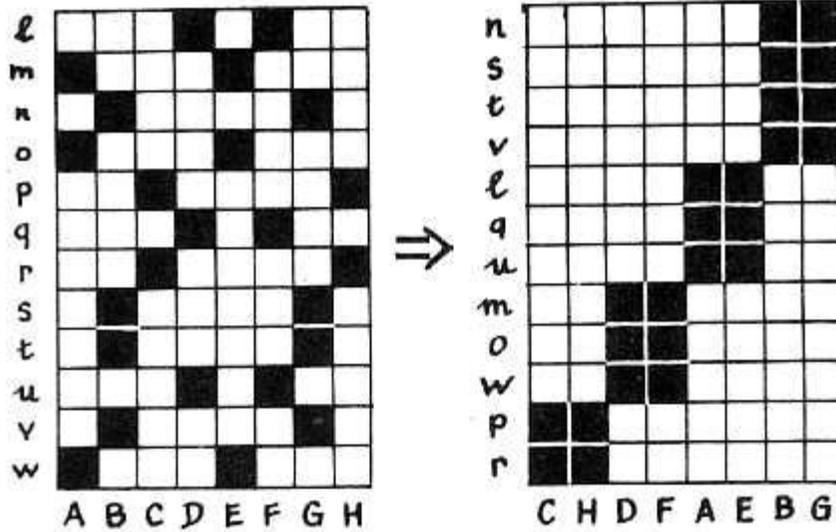
[Bertin2, p25]

Une barrière infranchissable

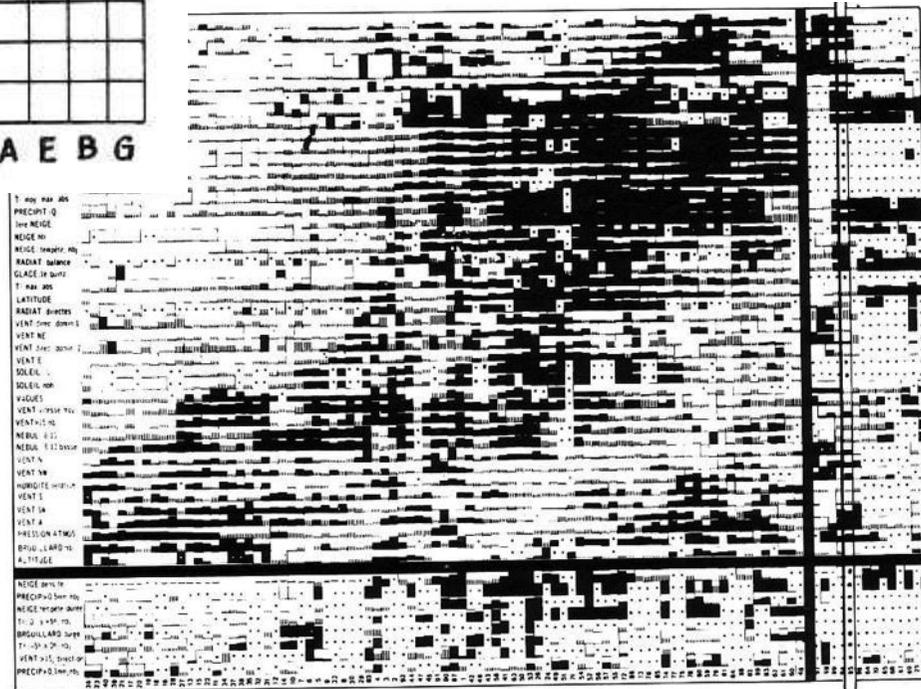
Jusqu'à trois lignes, un tableau de données peut être directement construit en une seule image. C'est un *diagramme de corrélation*. Il place les objets en z . Mais l'image n'a que trois dimensions. Cette barrière est infranchissable. En conséquence, au-delà de trois lignes, il n'y a que deux manières de transcrire l'information exhaustive :
- construire plusieurs diagrammes et perdre les relations d'ensemble;
- placer les objets en x et les caractères en y c'est-à-dire *construire une matrice*. Les relations d'ensemble sont découvertes grâce aux manipulations.



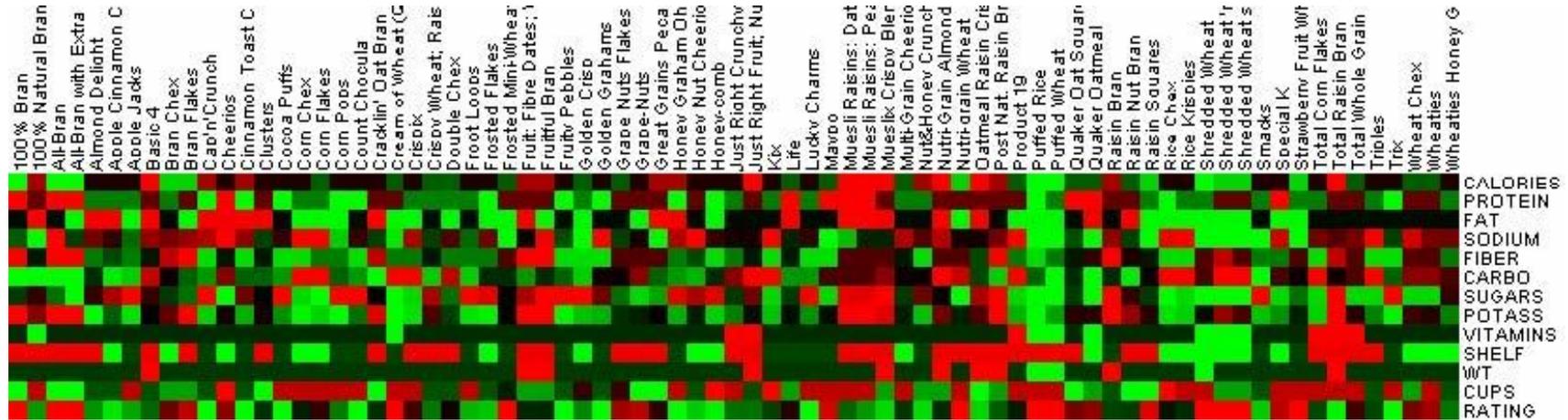
Matrices ordonnables (Bertin, 70')



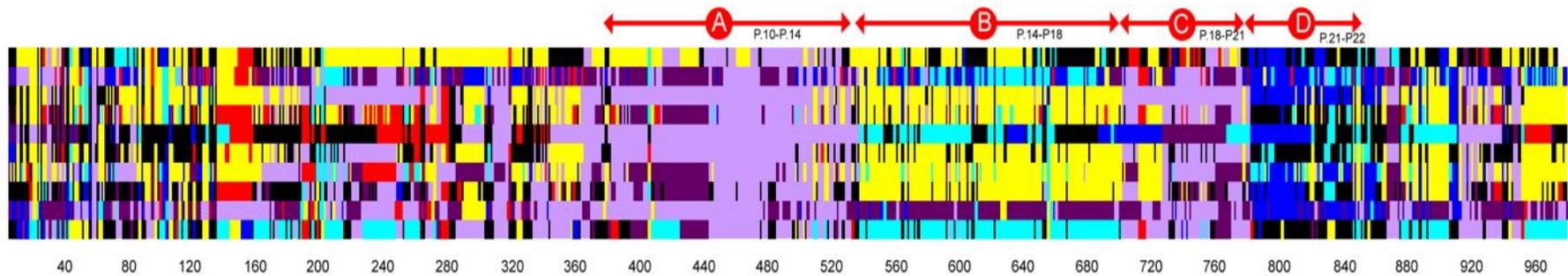
(cf cours #1)



Exemples :

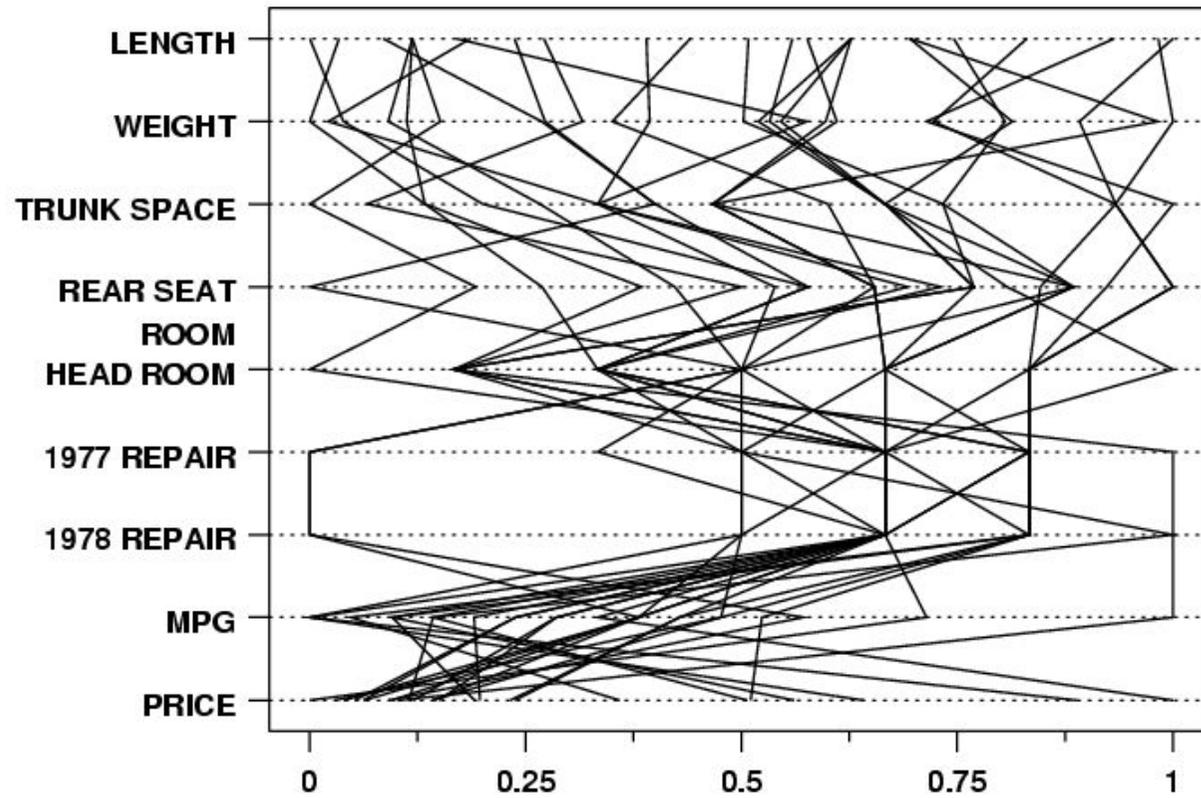


<http://hci.cs.umd.edu/trs/2005-20/2005-20.html>



Hsu & Cubaud, HCI'2009

Parallel coordinate plot



A. Inselberg, 1959

Nombreuses variantes de rendu

Google

Web **Images** Vidéos Actualités Shopping Maps Livres

Environ 6 530 000 résultats

Toutes les tailles
Grandes
Moyennes
Icônes

Toutes les couleurs
En couleur
Noir et blanc
Transparent

Tous les types
Visages
Photos
Images clipart
Dessins au trait
Images animées

Date indifférente
Moins de 24 heures
Moins d'une semaine

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Réutilisation autorisée sans but commercial

Outils par défaut

en.wikipedia.org
Parallel coordinates
400 × 400 - 155 ko - png

stackoverflow.com
parallel coordinates plot
800 × 600 - 265 ko - png

en.wikipedia.org
Parallel coordinate plot of
447 × 377 - 37 ko - png

evl.uic.edu
parallel coordinates plot
360 × 252 - 23 ko - gif

michaelvandanker.com
Parallel Coordinates Plot.
510 × 300 - 146 ko - png

stats.stackexchange.com
You can even use it as a
1050 × 1050 - 492 ko - png

hea-www.harvard.edu
The parallel coordinate plot
800 × 500 - 82 ko - jpg

infragistics.com
Rodolphe
639 × 365 - 130 ko - jpg

stackoverflow.com
enter image description here
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vis.pku.edu.cn
in Parallel Coordinates
640 × 229 - 248 ko - png

xistat.com
pcor3.gif
385 × 341 - 76 ko - gif

sci.utah.edu
Images:
847 × 462 - 224 ko - png

hea-www.harvard.edu
The parallel coordinate plot
800 × 500 - 72 ko - jpg

eagereyes.org
Parallel Coordinates
560 × 364 - 150 ko - png

github.com
Standardize to [0, 1]:
783 × 420 - 67 ko

vis.lbl.gov
to 3D parallel coordinates
800 × 347 - 214 ko - png

homes.cs.washington.edu
Parallel Coordinates
640 × 480 - 364 ko - png

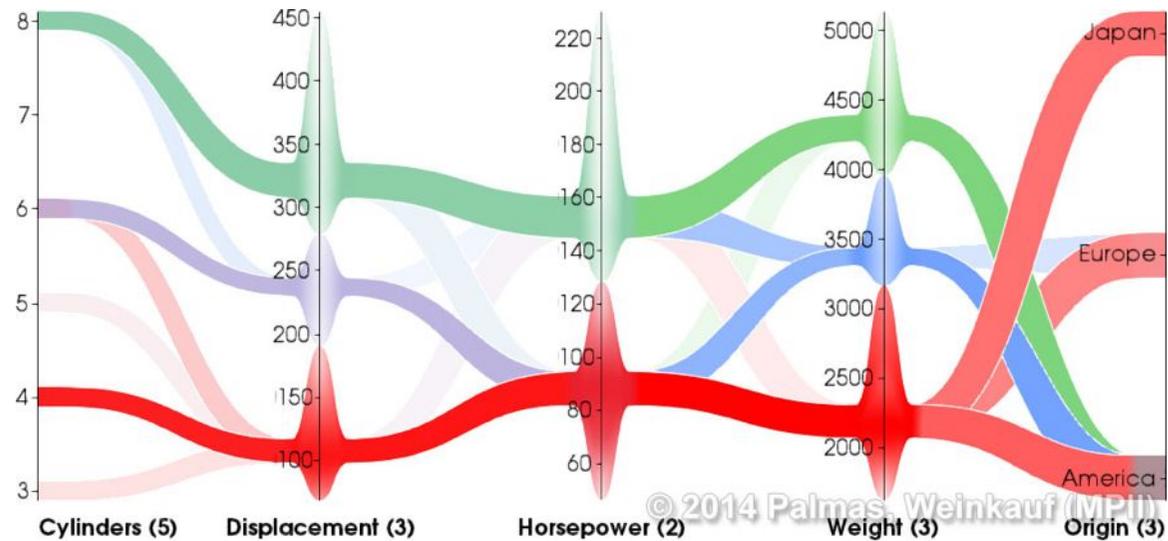
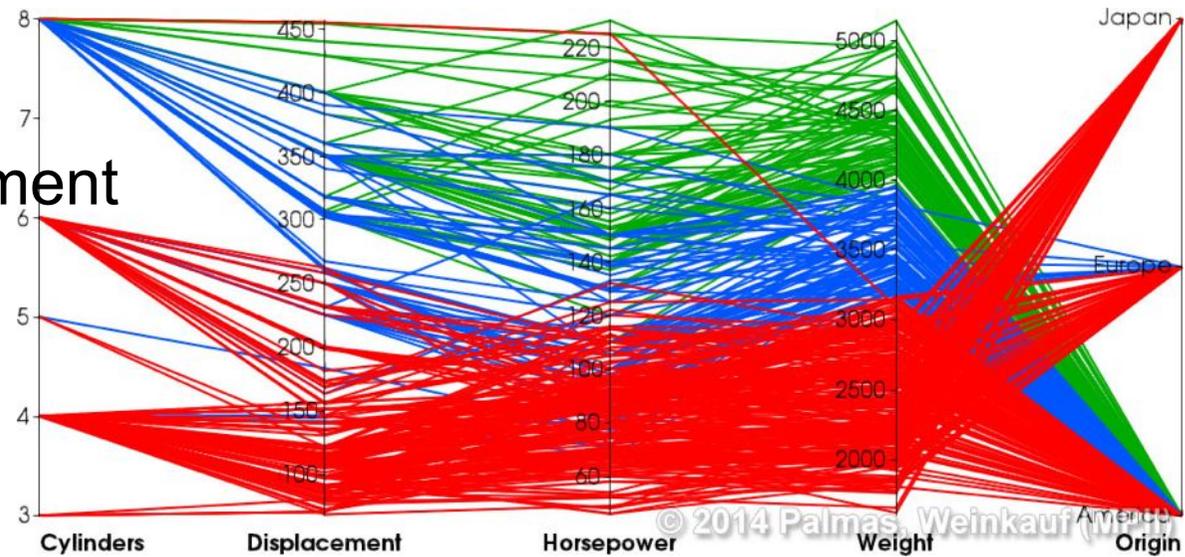
github.com
Data on the original scale:
708 × 427 - 43 ko

stn.spotfire.com
The parallel coordinate plot
450 × 246 - 23 ko - png

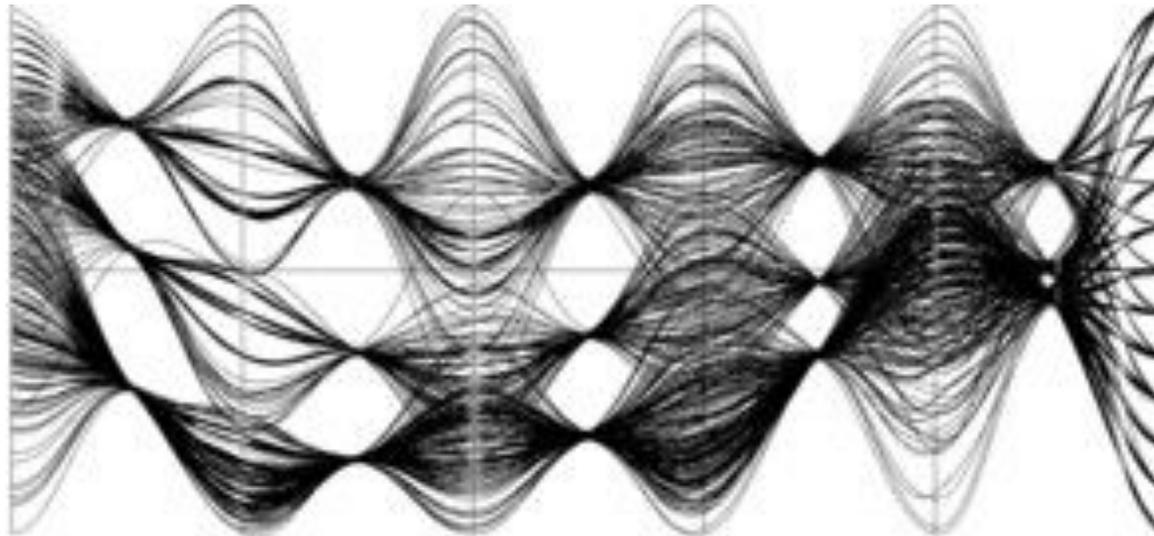
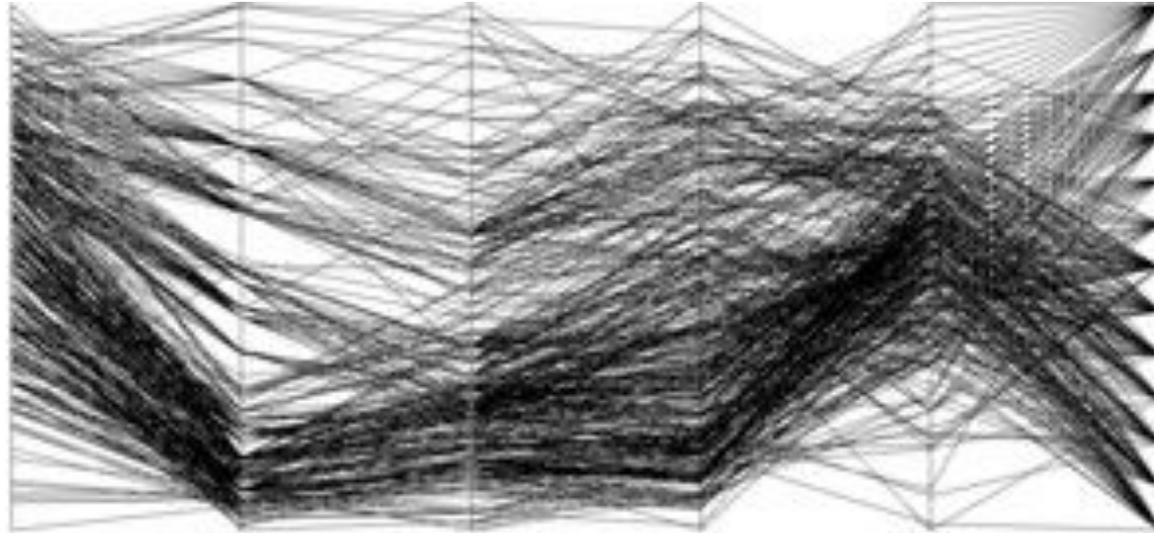
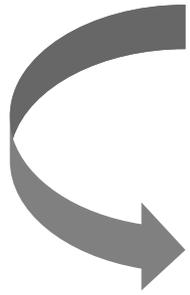
statistik.tuwien.ac.at
12.9: Parallel coordinate plot
576 × 288 - 48 ko - png

recherche d'images
dans Google
sur le terme

En particulier :
question du groupement
(bundling)



<http://www.csc.kth.se/~weinkauff/>



<https://www.vis.uni-stuttgart.de/forschung/infovis-visualanalytics/parallel-coordinates.html>

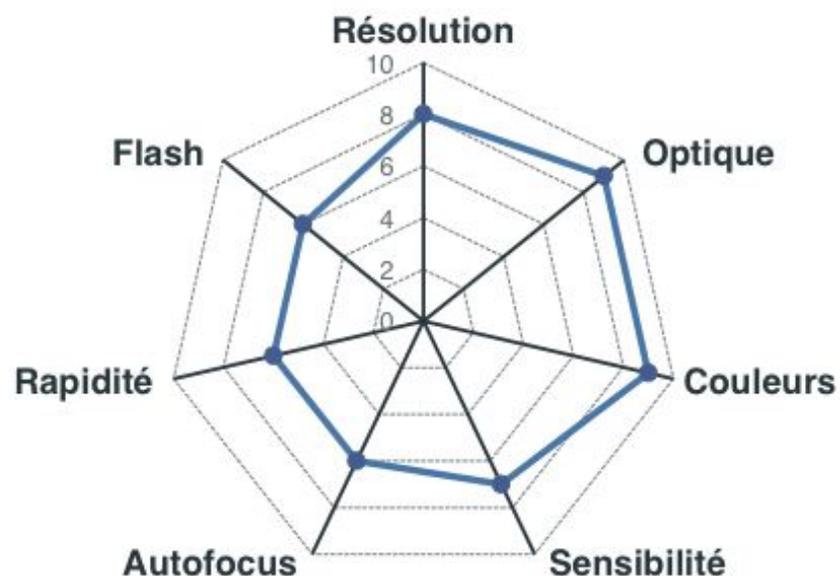
Diagramme en étoile

(ou : star plot, radar, diagramme de Kiviat ...)

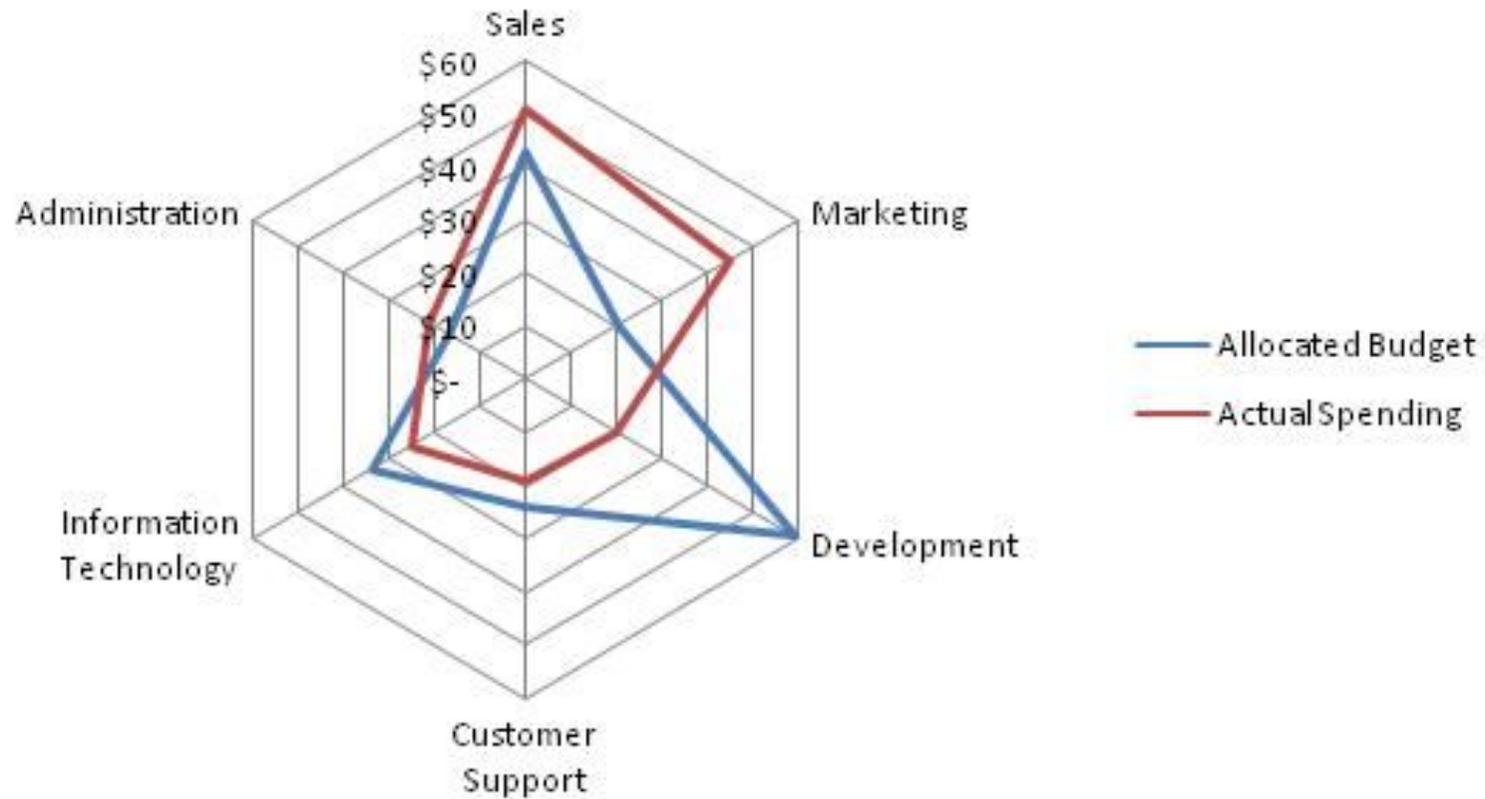
Labo Fnac



Le Samsung WB35F est abordable est doté d'un capteur au format APS-C (18,7 mm) et d'un écran de 2,7" (6,7 cm) affichant une résolution de 1080p. La résolution initiale du capteur est de 15,9 millions de pixels. Le Samsung WB35F a obtenu de bons résultats aux tests optiques, avec un grand-angle de 24 mm et d'un zoom optique de 3x. Le mode macro permettant une mise au point à 10 cm. Le Samsung WB35F a décroché des notes correctes en matière de rapidité et de sensibilité et une excellente note de précision. Son autofocus manque un peu de réactivité. En matière de traitement d'image, le Samsung WB35F manque de naturel, la vitesse n'est pas son point fort. Le Samsung WB35F communique et intègre Wi-Fi et NFC pour partager ses photos et vidéos directement ou au travers d'un smartphone. Il peut filmer des vidéos en 720p à 30 images/s.



en superposition :



http://upload.wikimedia.org/wikipedia/commons/1/18/Spider_Chart2.jpg

Les graphes

cf cours
sur la fouille
de graphe

Introduction Éléments de théorie des graphes 14 / 63

Définitions

Un graphe est défini par un couple $G = (V, E)$ tel que :

- V (pour l'anglais *vertices*) est un ensemble fini de sommets
- E (pour l'anglais *edges*) est un ensemble fini de arêtes

Un graphe peut être orienté, ou non :

- si oui, les couples $(v_i, v_j) \in E$ sont ordonnés, v_i est le sommet initial, v_j est le sommet terminal.
- on appelle alors le couple (v_i, v_j) un *arc*, représenté graphiquement par une flèche.
- si non, les couples ne sont pas orientés et (v_i, v_j) est appelé *arête*, représenté par $v_i - v_j$

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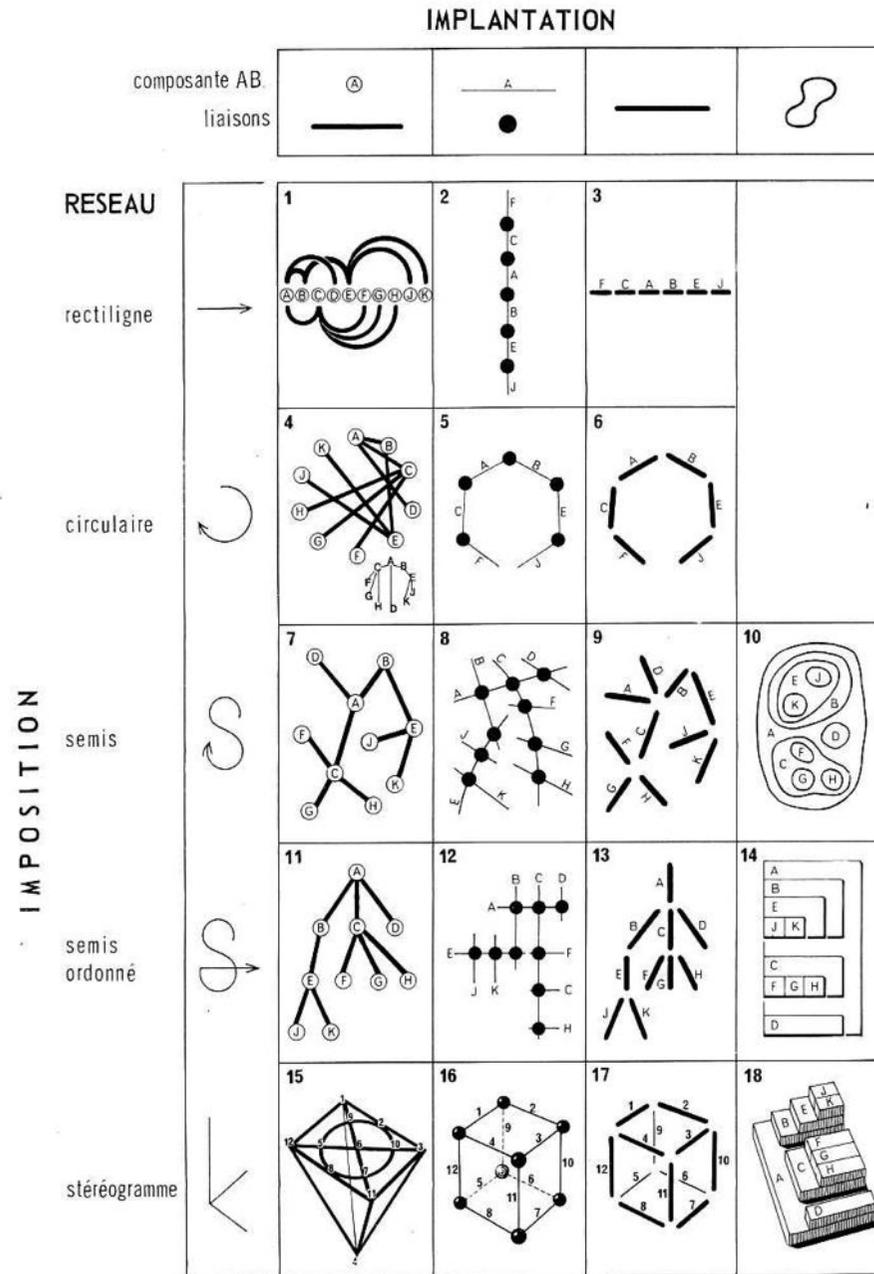
Terminologie

- l'**ordre** d'un graphe, c'est son nombre de sommets (souvent désigné par n).
- une **boucle** est un arc/une arête reliant un sommet à lui-même
- un graphe dépourvu de boucle est dit **élémentaire**
- un graphe **simple** ne comporte pas de boucle et au plus une arête entre deux sommets
- un graphe **partiel** est le graphe obtenu en supprimant certains arcs ou arêtes
- un **sous-graphe** est le graphe obtenu en supprimant certains sommets et tous les arcs/arêtes incidents aux sommets supprimés.
- un graphe est dit **complet** s'il comporte une arête (v_i, v_j) pour toute paire de sommets $(v_i, v_j) \in E^2$.
- un sommet v_i est dit **adjacent** (familièrement on parle de **voisins**) à un autre s'il existe une arête entre eux.
- le **degré** d'un sommet est le nombre de d'arêtes incidentes à ce sommet.

le cnam

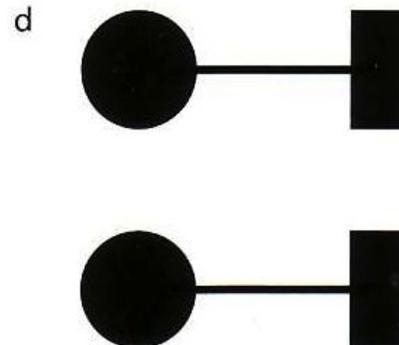
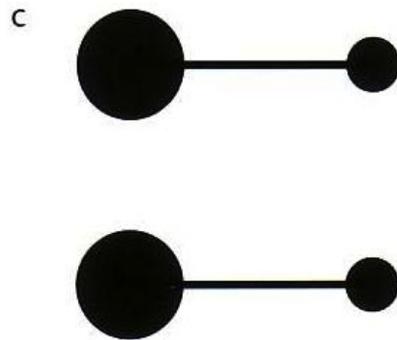
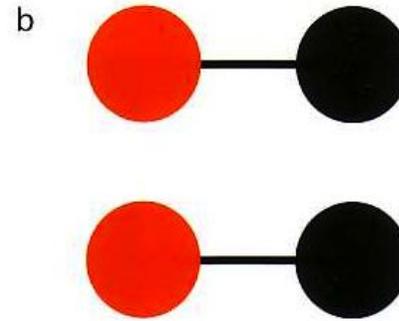
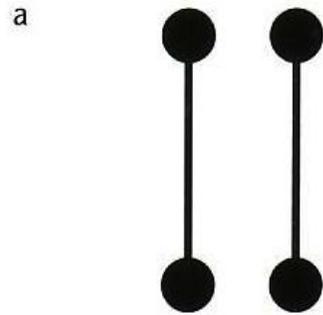
Représentation des graphes

[Bertin2]



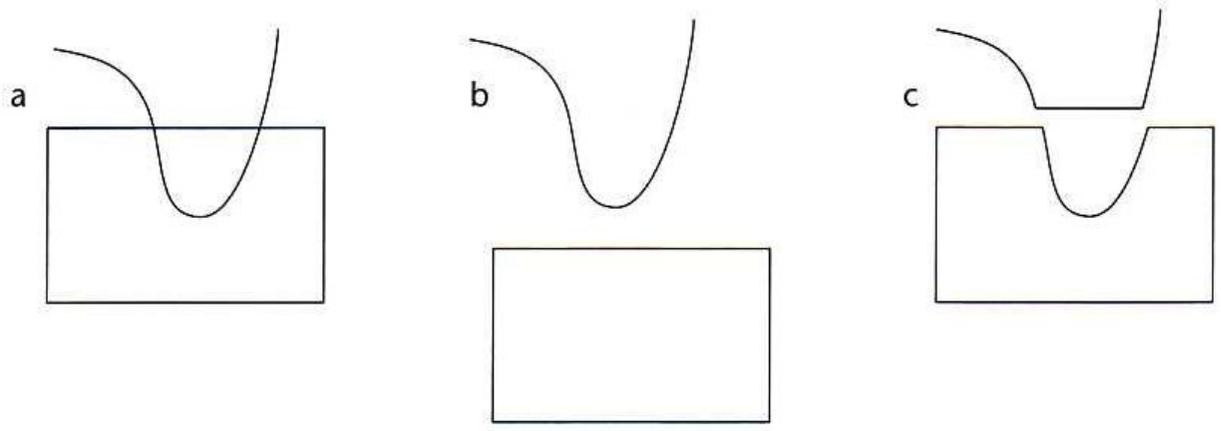
arbres
ok

Les relations

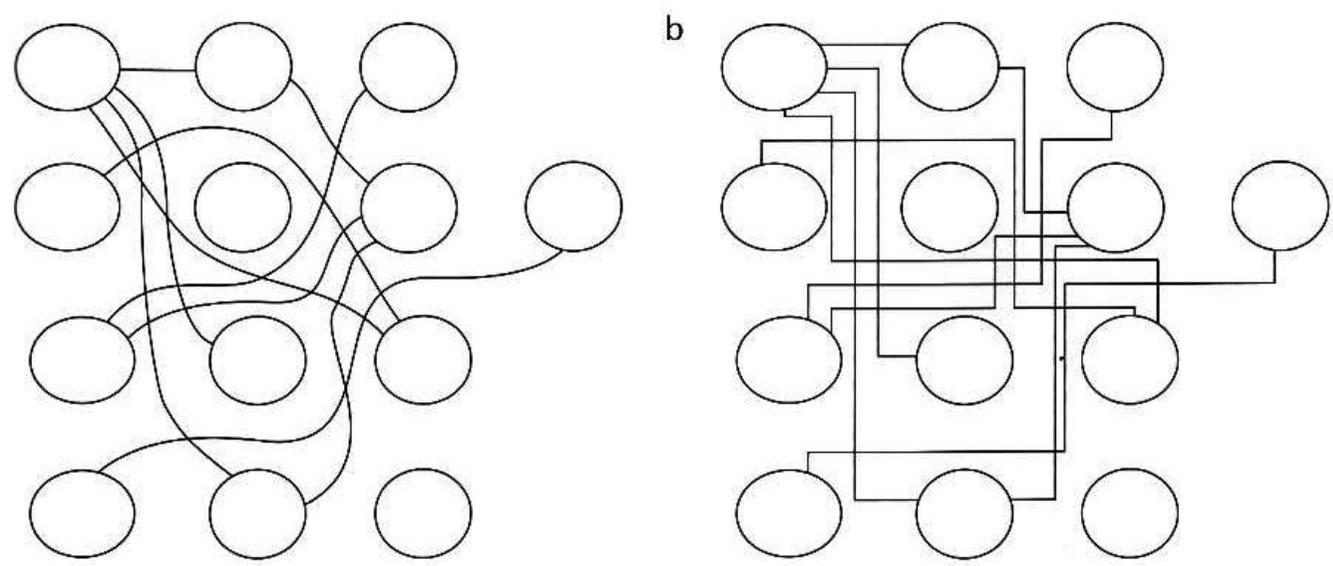


Connectedness is a powerful grouping principle that is stronger than (a) proximity, (b) color, (c) size, or (d) shape.

[Ware]



The pattern on the left (a) is perceived as a curved line overlapping a rectangle (b) rather than as the more angular components shown in (c).



[Ware]

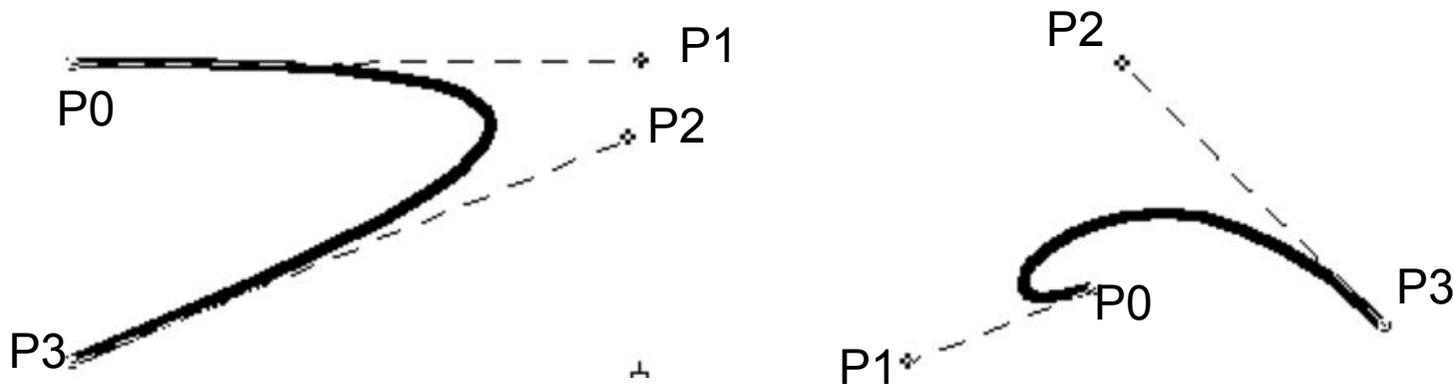
In (a), smooth continuous contours are used to connect the elements, whereas in (b), lines with abrupt changes in direction are used. It is much easier to perceive connections when contours connect smoothly.

Remarque sur les arcs non rectilignes :

utilisation des courbes paramétrées (Bézier, Splines)

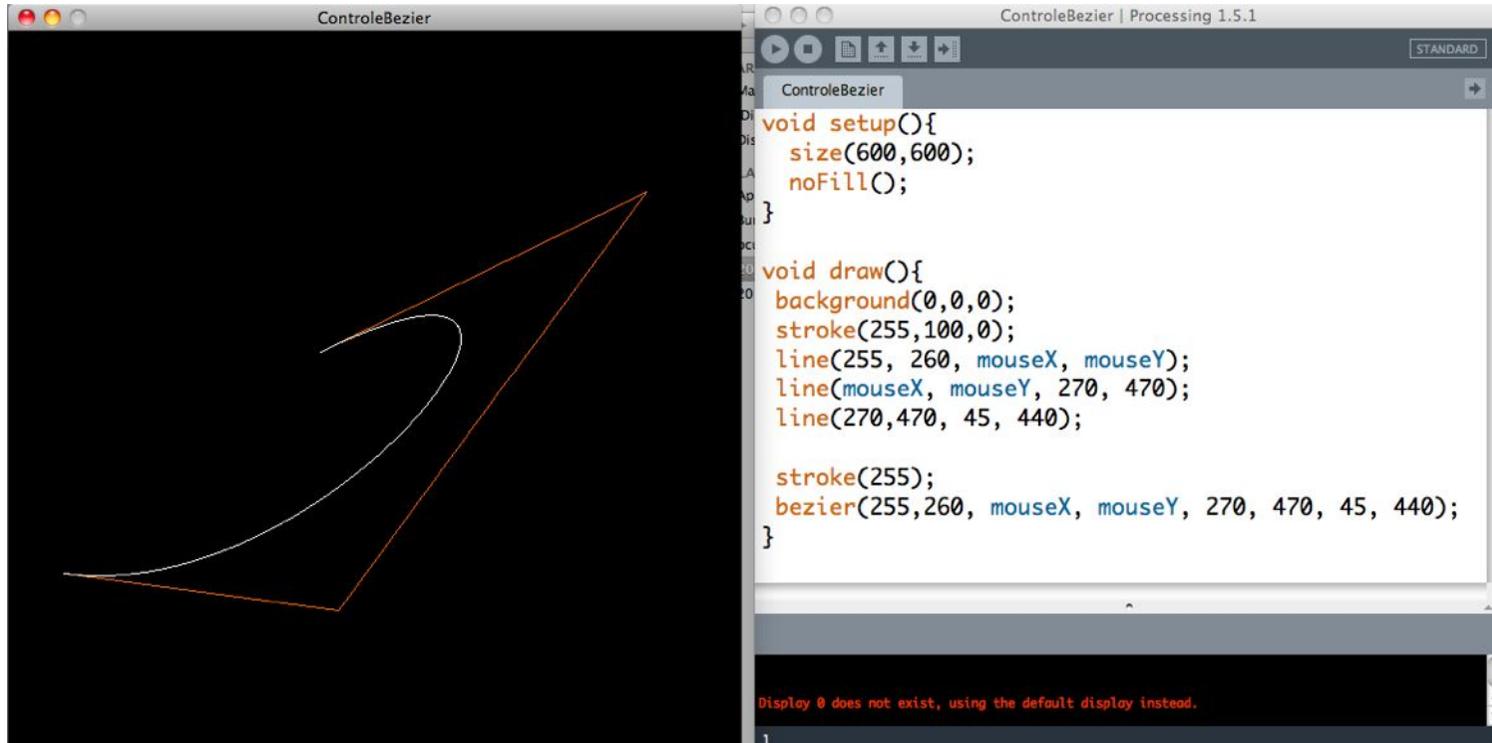
$$f(u) = \sum_{i=0}^3 B_i(u) \vec{P}_i \quad \text{polynôme de degré 3}$$

$$= \vec{P}_0(1-u)^3 + 3\vec{P}_1u(1-u)^2 + 3\vec{P}_2u^2(1-u) + \vec{P}_3u^3$$



voir cours NSY116 (chapitre sur les techniques graphiques 2D)

Primitive bezier() de Processing



Spline de Catmull-Rom sous Processing :

Name

`curveVertex()`

Examples



```
noFill();  
beginShape();  
curveVertex(84, 91);  
curveVertex(84, 91);  
curveVertex(68, 19);  
curveVertex(21, 17);  
curveVertex(32, 100);  
curveVertex(32, 100);  
endShape();
```

Description

Specifies vertex coordinates for curves. This function may only be used between **beginShape()** and **endShape()** and only when there is no MODE parameter specified to **beginShape()**. The first and last points in a series of **curveVertex()** lines will be used to guide the beginning and end of a the curve. A minimum of four points is required to draw a tiny curve between the second and third points. Adding a fifth point with **curveVertex()** will draw the curve between the second, third, and fourth points. The **curveVertex()** function is an implementation of Catmull-Rom splines. Using the 3D version of requires rendering with P3D or OPENGL (see the Environment reference for more information).

3. Petits multiples



[Tuftes – Envisioning ...]

Conclusion

Well-designed small multiples are

- inevitably comparative
- deftly multivariate
- shrunken, high-density graphics
- usually based on a large data matrix
- drawn almost entirely with data-ink
- efficient in interpretation
- often narrative in content, showing shifts in the relationship between variables as the index variable changes (thereby revealing interaction or multiplicative effects).

[Tufte – Envisioning ...]

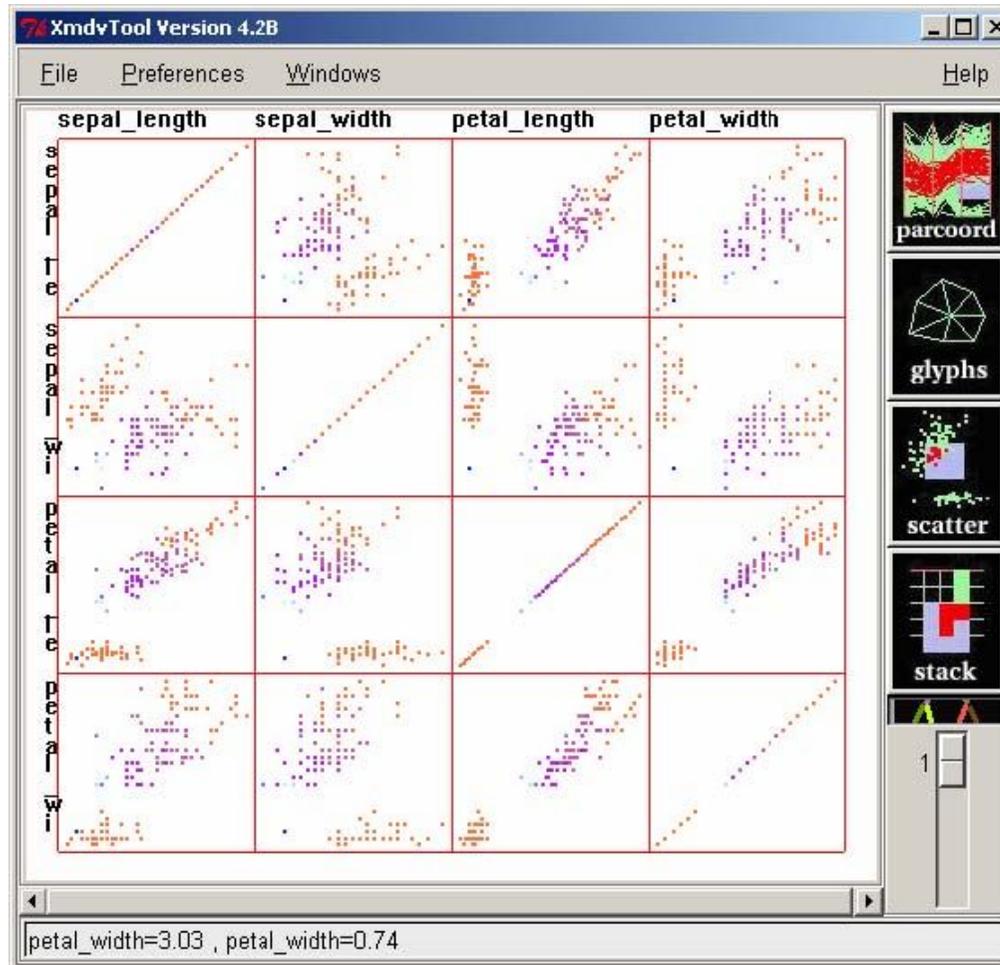
Small multiples reflect much of the theory of data graphics:

For non-data-ink, less is more.

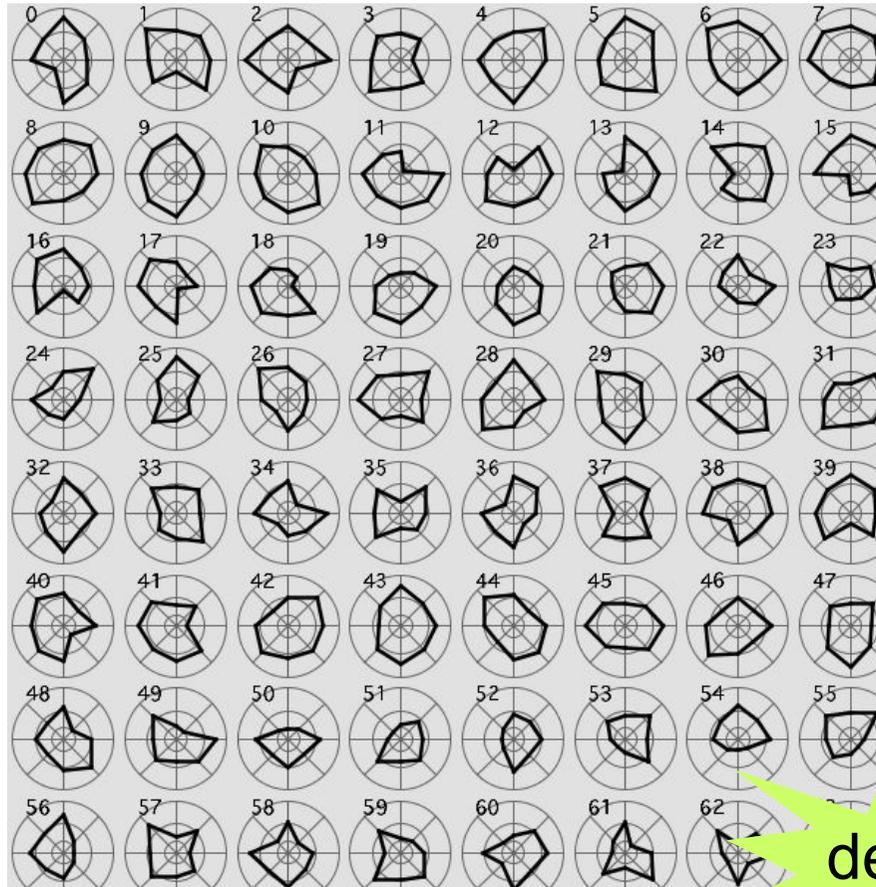
For data-ink, less is a bore.⁶

⁶The two aphorisms on the meaning of “less” are, respectively, credited to Ludwig Mies van der Rohe and to Robert Venturi, *Complexity and Contradiction in Architecture* (New York, second edition, 1977), p. 17.

PM avec les nuages de points

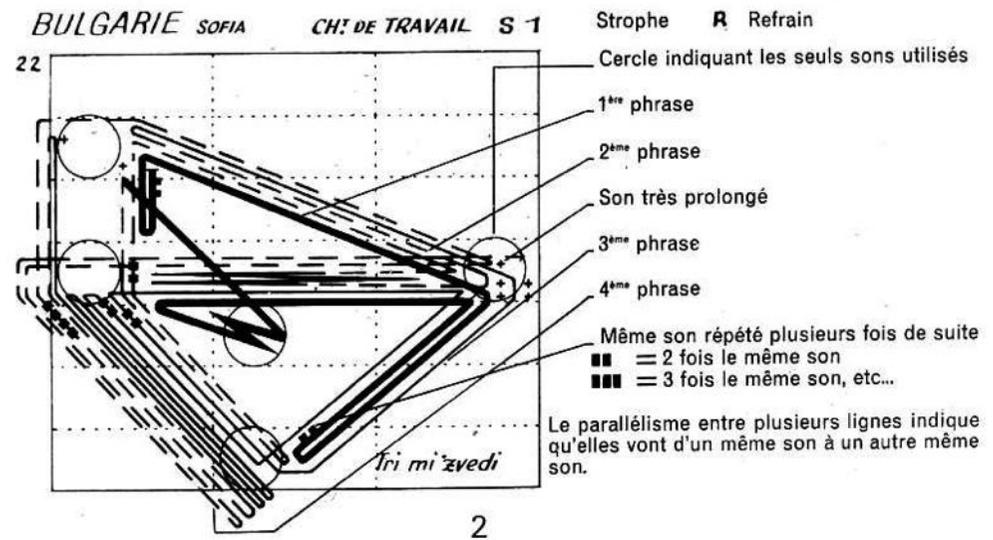
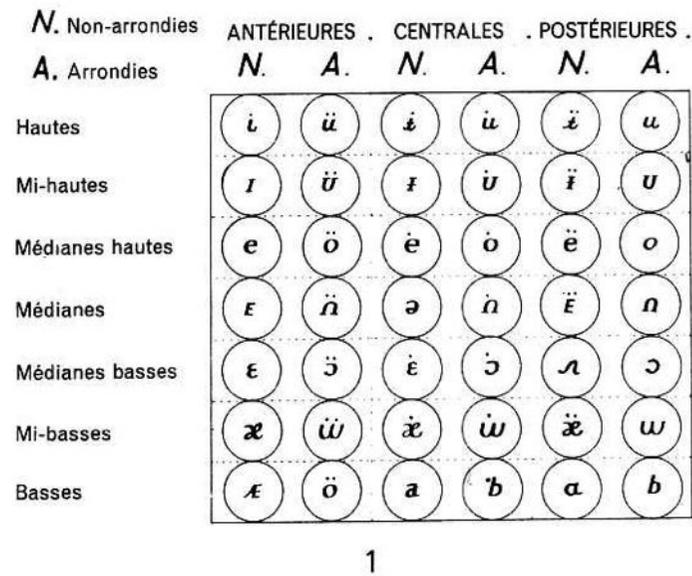


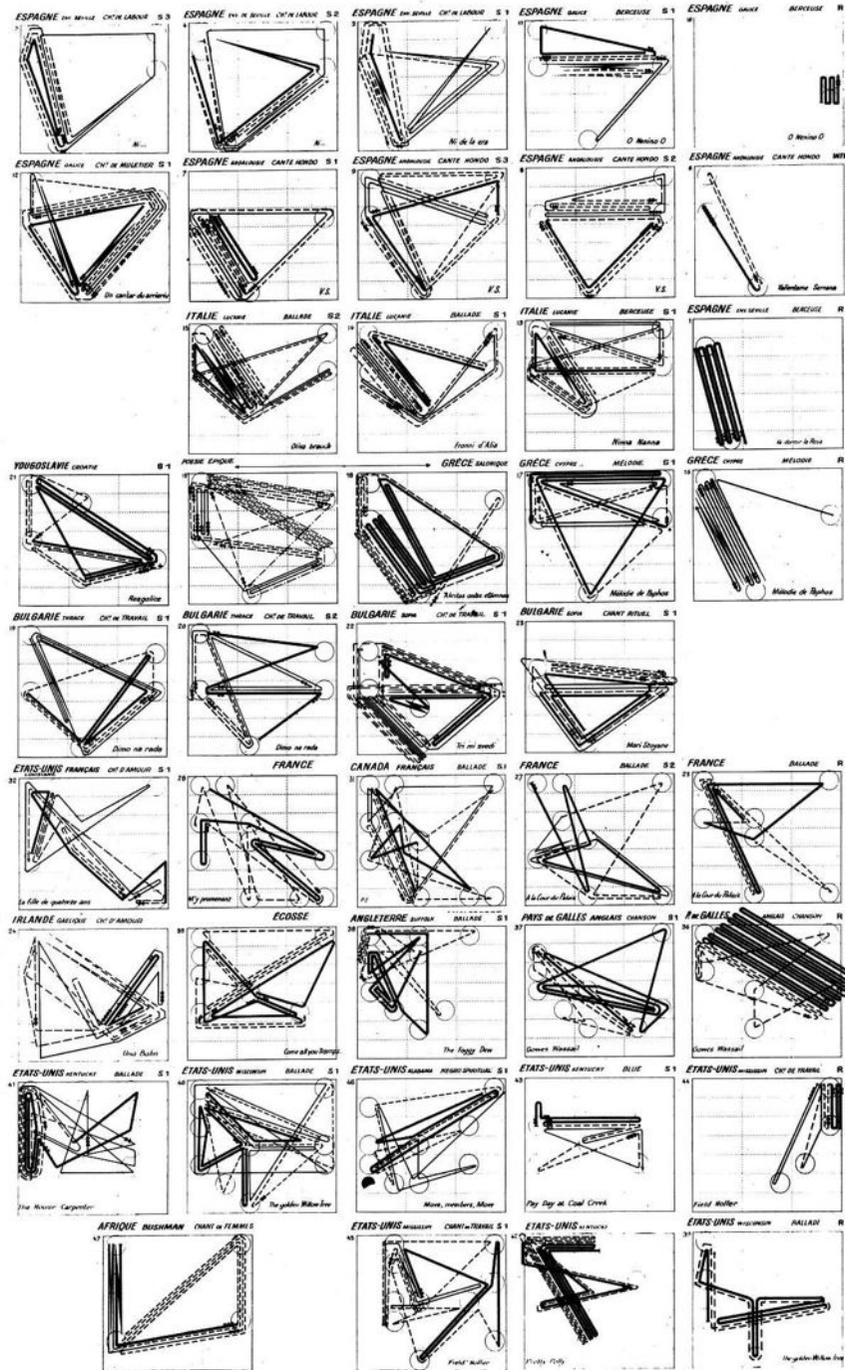
PM avec les radars



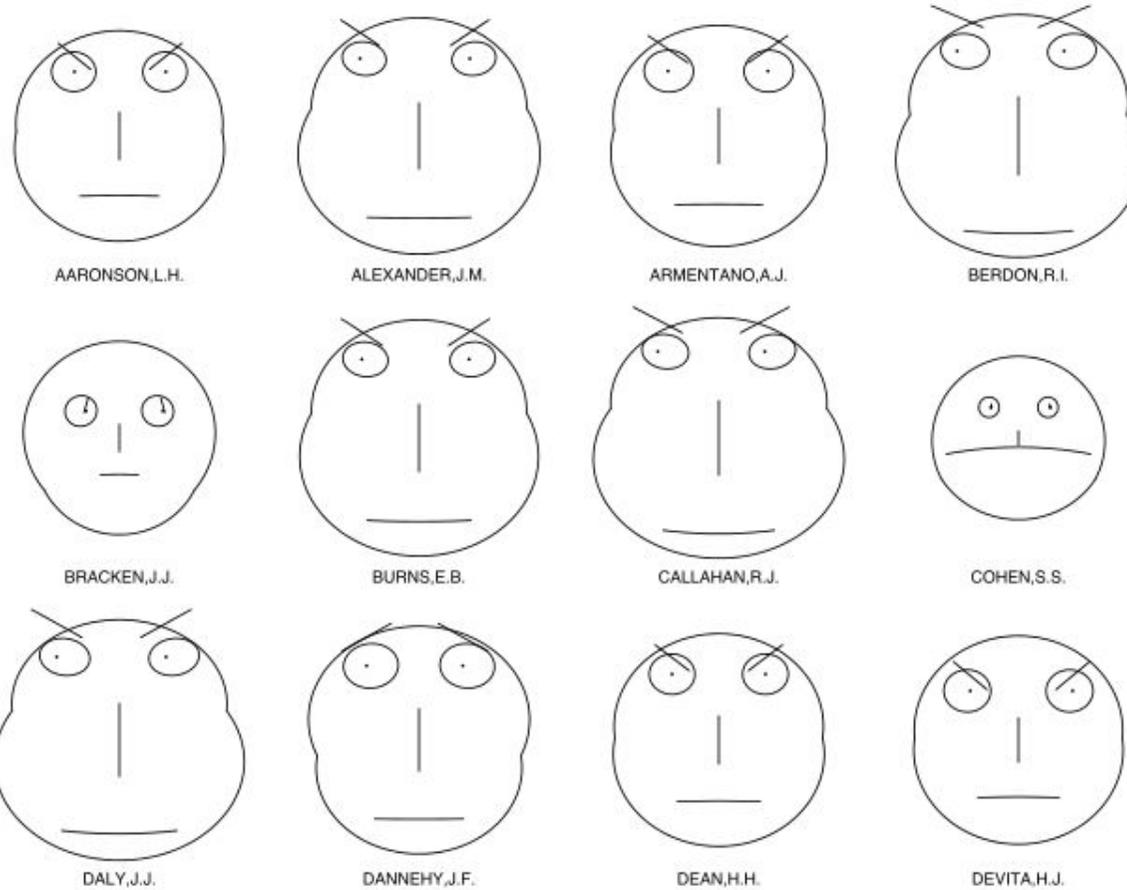
demo

Exemple dans [Bertin]



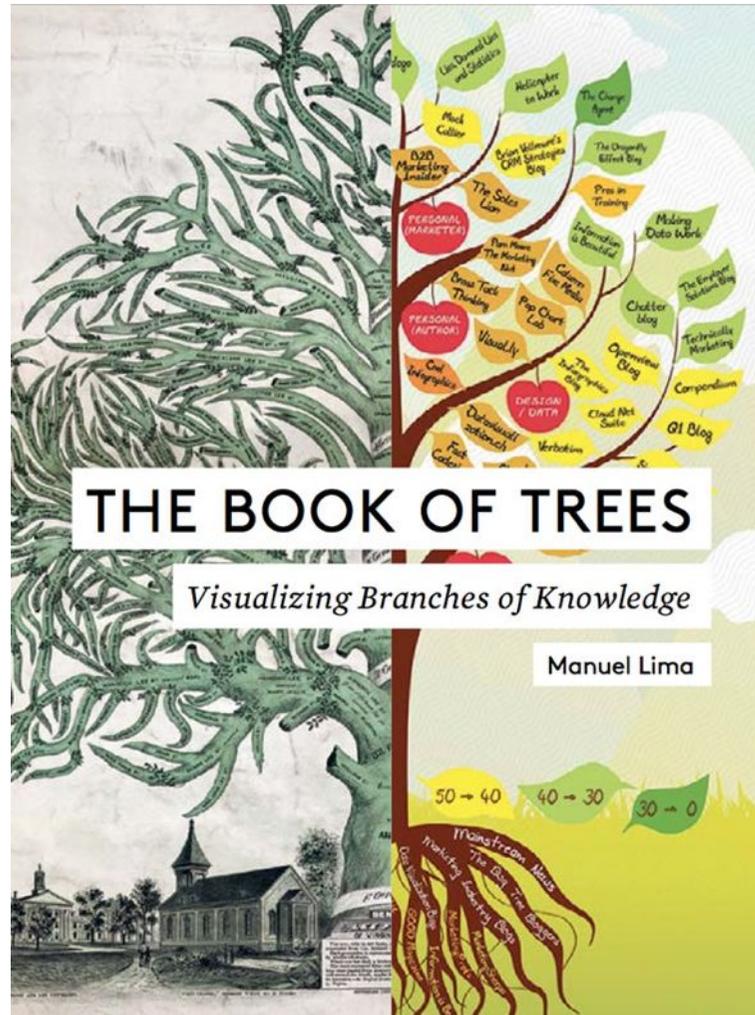


au passage : les visages de H. Chernoff (1973)

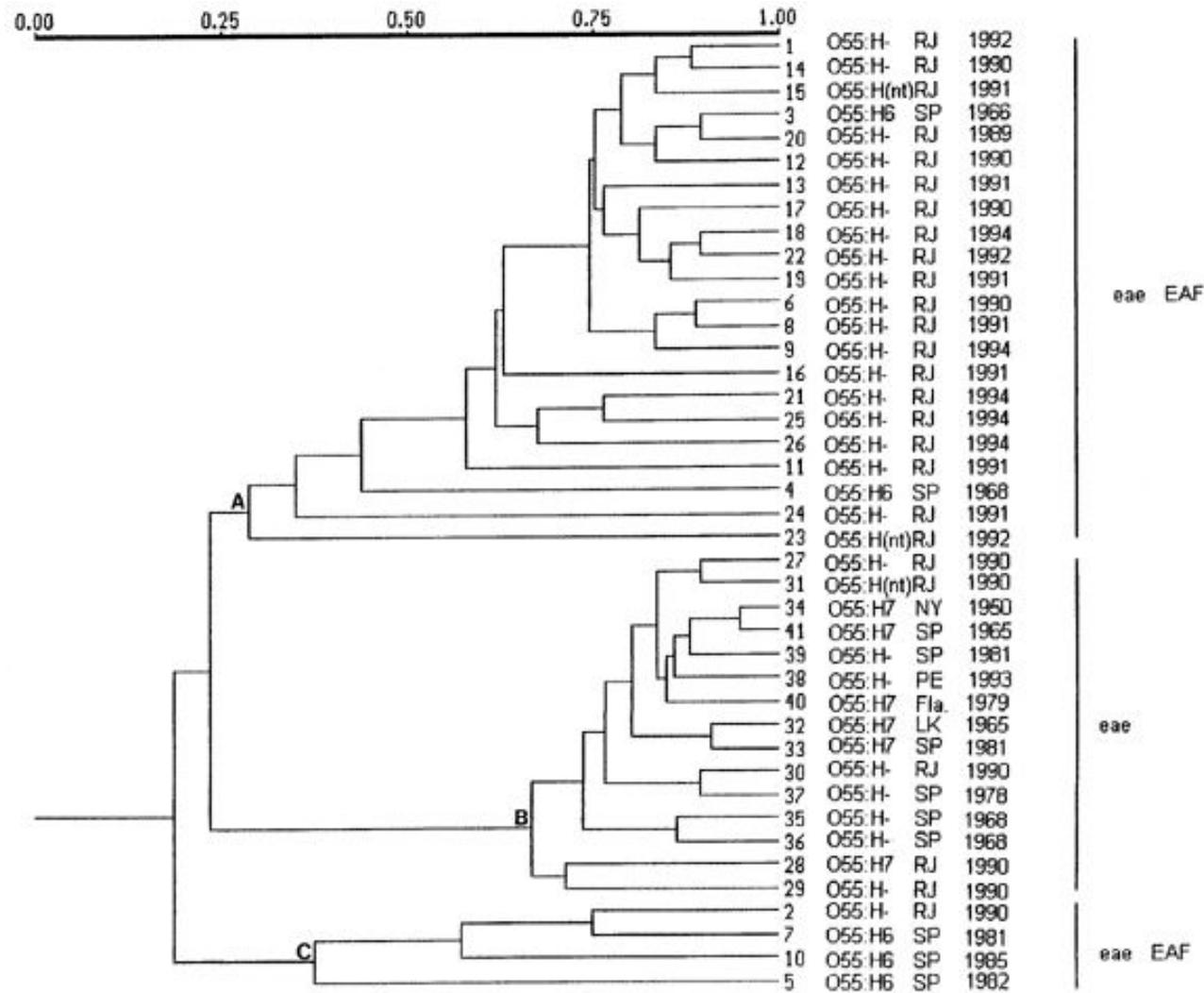


http://en.wikipedia.org/wiki/Chernoff_face

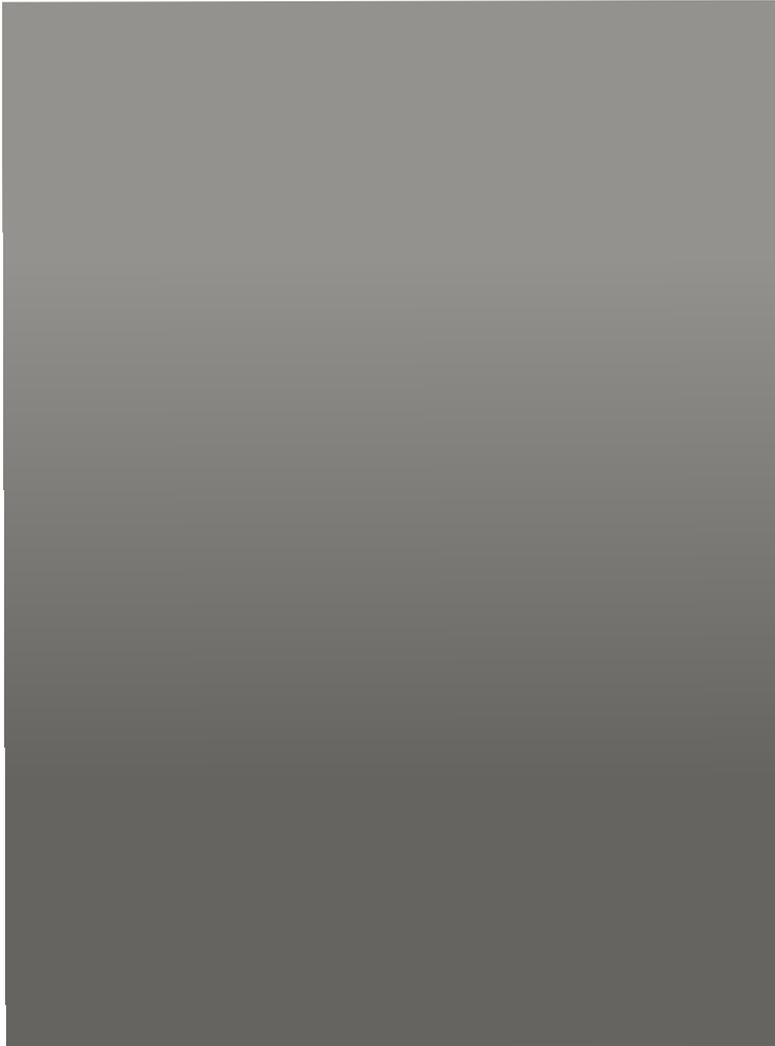
4. Les arbres



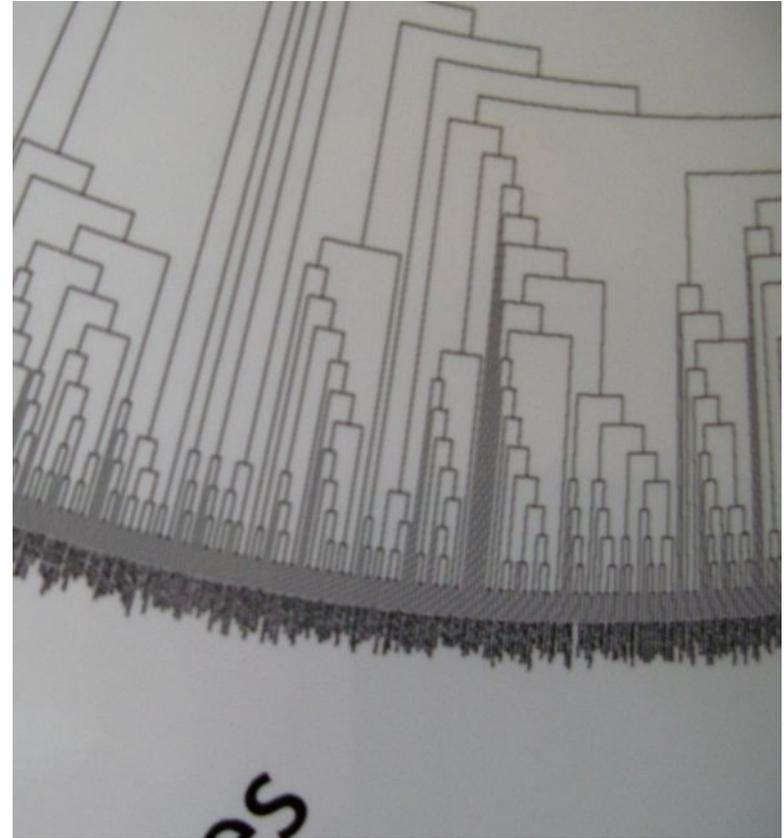
Dendrogrammes



Représentations radiales

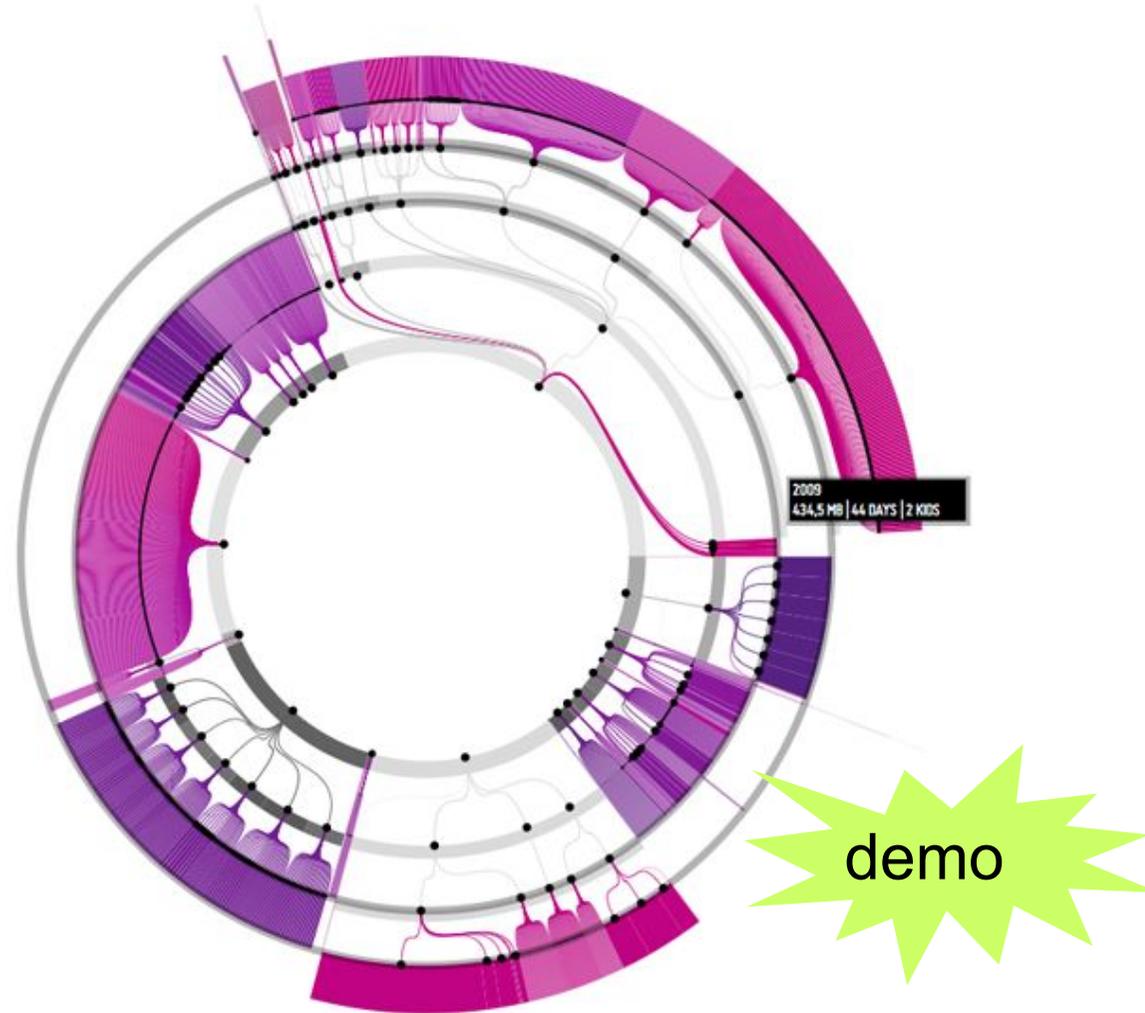


Un exemple : classer les espèces vivantes sur Terre



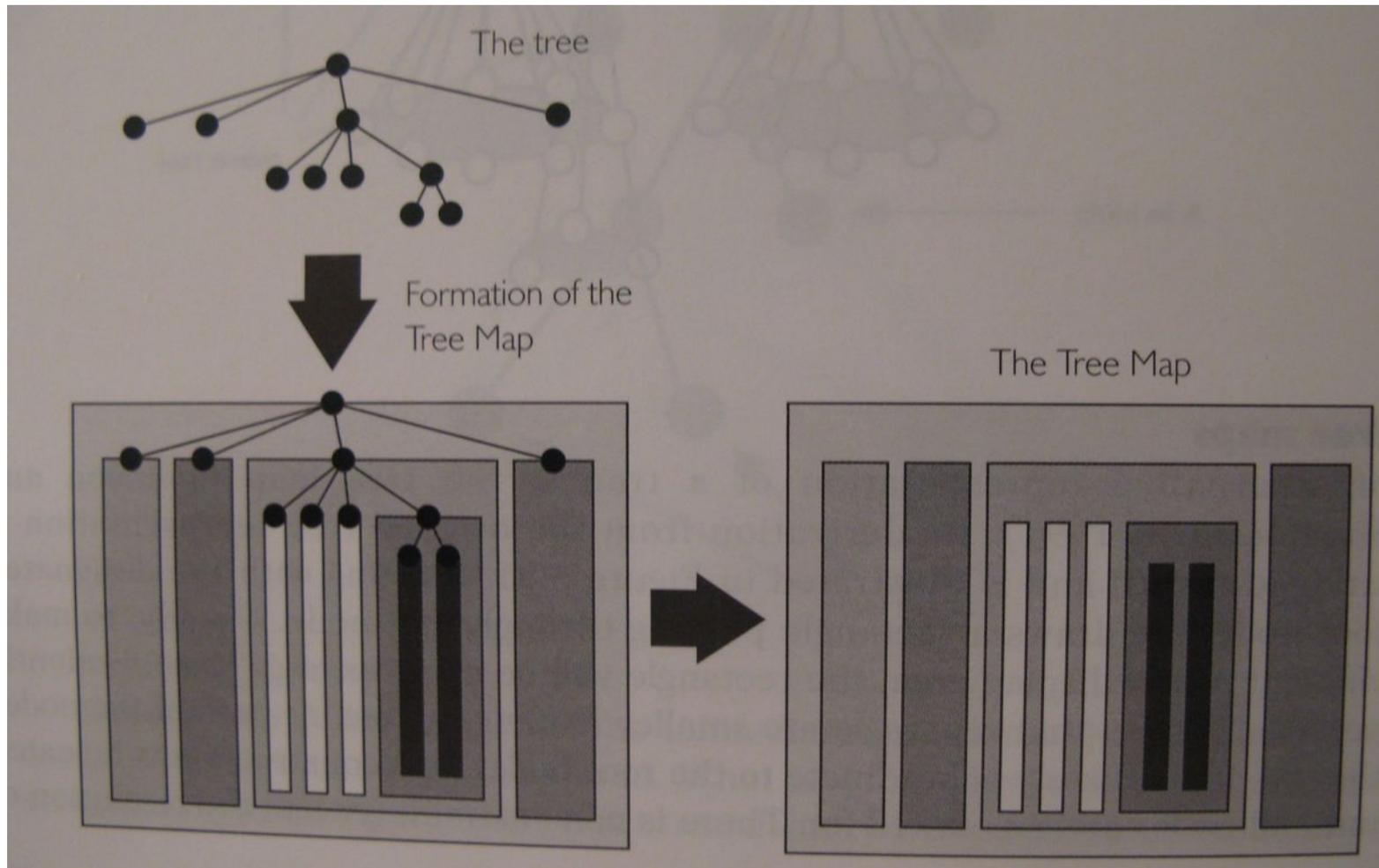
Panneau 1.50x1m env.
Noms illisibles => IHM

Chapitre M.5.0 de "Design génératif"



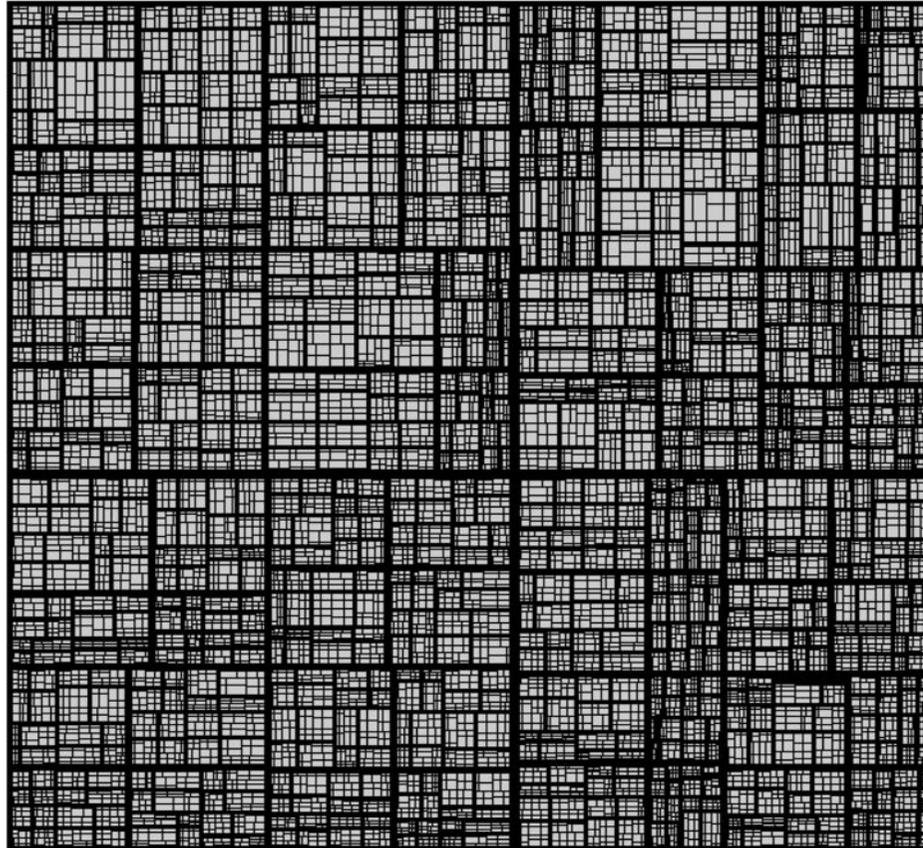
Programme Processing très complet (M_5_5_01_TOOL)

Tree-maps (Johnson & Schneiderman, 1991)



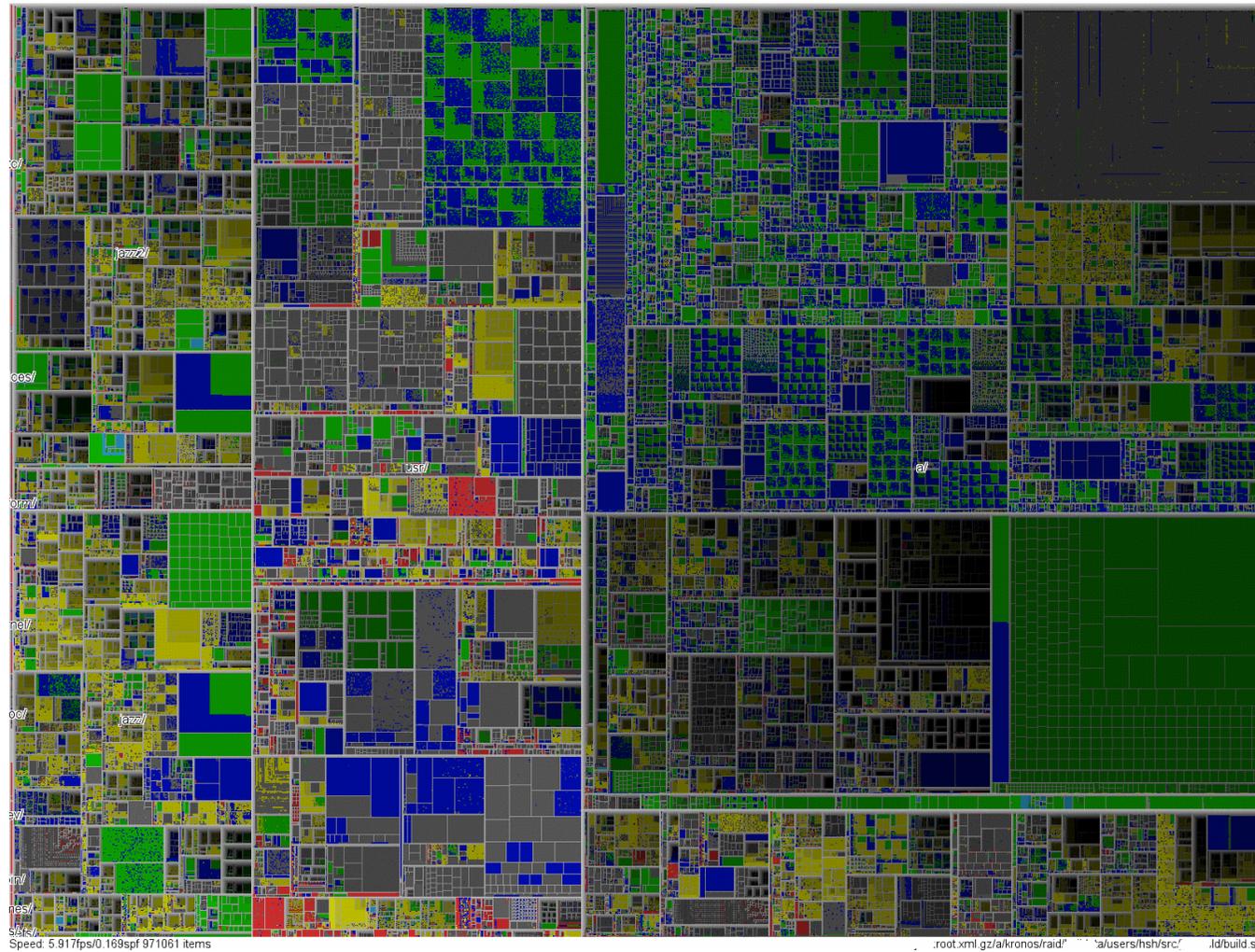
[Spence p. 86]

rappel du TP#1 : subdivision récursive du plan



algo. à étudier au TP#4

Treemap avec un million d'items (Fekete, Plaisant – 2002)



code source et infos : <http://www.cs.umd.edu/hcil/millionvis/>

Autre exemple : newsmap

newsmap

http://marumushi.com/apps/newsmap/newsmap.cfm

EDINFOVIZ LIVRE3D-EN-FRANCE Deptinfo seloger monrouteur webmailCNAM googleBooks AbeBooks Amazon Apple eBay UTILES

newsmap

about permalink + SELECT ALL COUNTRIES

AUSTRALIA AUSTRIA CANADA FRANCE DEUTSCHLAND INDIA ITALIA NEW ZEALAND ESPANA U.S.

US

Gaza conflict complicates Obama quest for peace

Black Boxes in Hand, Full Story Emerges

No breakup at Citigroup

When a Rock Star CEO Leaves the Stage

Familiarity Breeds Contempt in Steelers-Ravens Showdown

Once burned, twice shy - why the Gruden-Davis match can't be reit

St. Louis seems upbeat after Rams hired Steve Spagnuolo

NY Range rs

The Starbur: Round 4, Sony Open in Hawaii

Bedlam breaks out at Circuit City

US Airways Jet Lifted From Hudson

Chrysler Financial gets federal loan

Wake Forest pulls away from Clemson to remain undefeated

Sports digest

Intel's Net Plunges as Demand Dries Up

Regulators close Bank of Clark County

Missing money managed behind olive branches

Slight dusting of snowfalls possible today

Allen is taking steps

St. Louis Cardinals clinch Post Office

Price details unclear in murky Russia-Ukraine deal

North Korea Claims To Have Weaponized Plutonium; Threatens to ...

Somali Islamists execute "spy" for Ethiopians

Osama bin Laden by MJ Akbar

Israel eyes expanded Egyptian force at Gaza border

The Past as a Guide for Obama's Inaugural Address

At confirmation, two views of Holder emerge

New tack for King Day celebration in SF

Another decision on Michelle Obama's plate

Little Debbie peanut butter crackers recalled

Music biopics try to keep it real

How Wyeth's "Helga" Went Viral Before Viral Existed

Digital TV Delay Runs Into Protest

FOC Report Points Rocky Pictures of Martin's Tenure

Pakistan gives probe team 10 days

Six Guantanamo Bay detainees released

Venezuela's Chavez urges tear gas against protests

7 Killed, dozens wounded in Afghanistan attacks

Gitmo detainees lawyers raise torture allegations

Obama's race help or hurt black America?

Congress goes along with Obama for now

Obama honors war dead at Arlington, attends church

Obama's wife at odds in America's promise

Obama for young readers

Will Obama's race help or hurt black America?

Obama's wife at odds in America's promise

Obama for young readers

Obama's wife at odds in America's promise

Obama for young readers

Obama's wife at odds in America's promise

Obama for young readers

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Obama's wife at odds in America's promise

Obama for young readers

Obama's wife at odds in America's promise

Sunday January 18, 2009 21:51

+ SELECT ALL CATEGORIES

LAYOUT: SQUARIFIED STANDARD

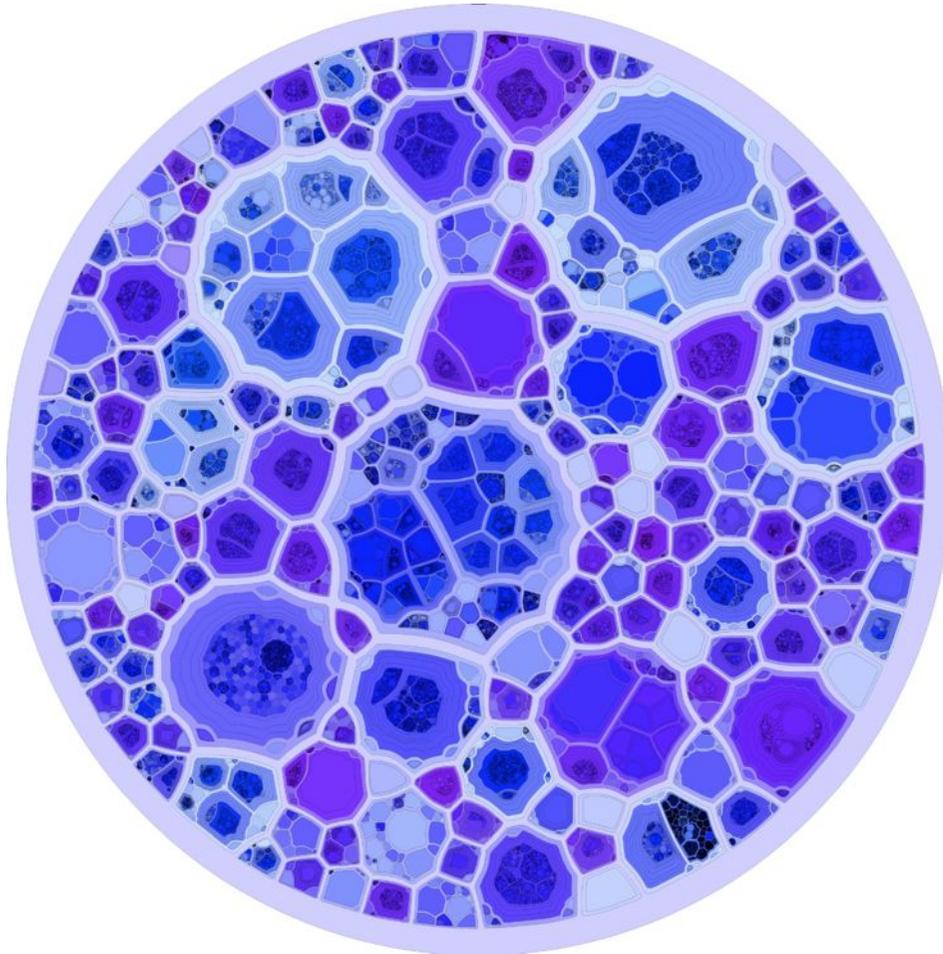
LESS THAN 10 MINUTES AGO WORLD NATION BUSINESS TECHNOLOGY SPORTS ENTERTAINMENT HEALTH

MORE THAN 10 MINUTES AGO

MORE THAN 1 HOUR AGO

| ARCHIVED | | TODAY | | | | |
|----------|-----|-------|-----|-----|-------|-------------------------------------|
| MON | TUE | WED | THU | FRI | YEST. | TODAY |
| 00:00 | | | | | | <input checked="" type="checkbox"/> |
| 06:00 | | | | | | |
| 12:00 | | | | | | |
| 18:00 | | | | | | |

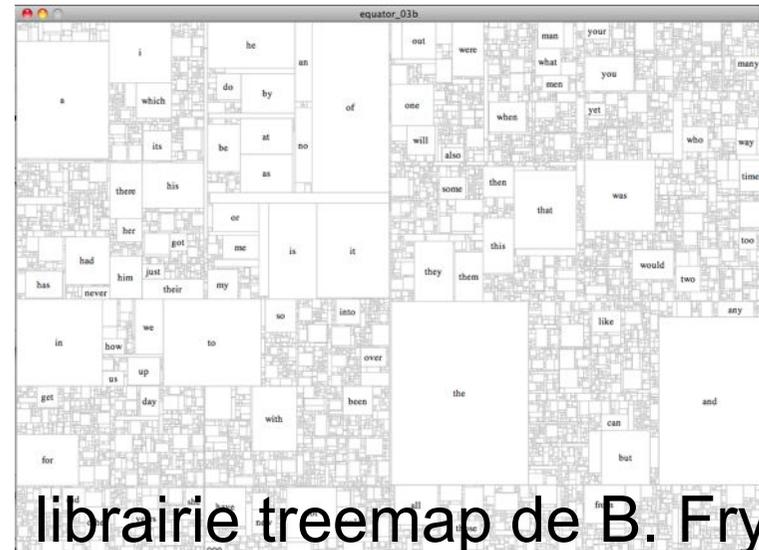
Nombreuses variantes



<http://www.informatik.uni-konstanz.de/deussen/mitarbeiter/oliver-deussen/olivers-kunschtversuche/>



<http://grandperspectiv.sourceforge.net/>



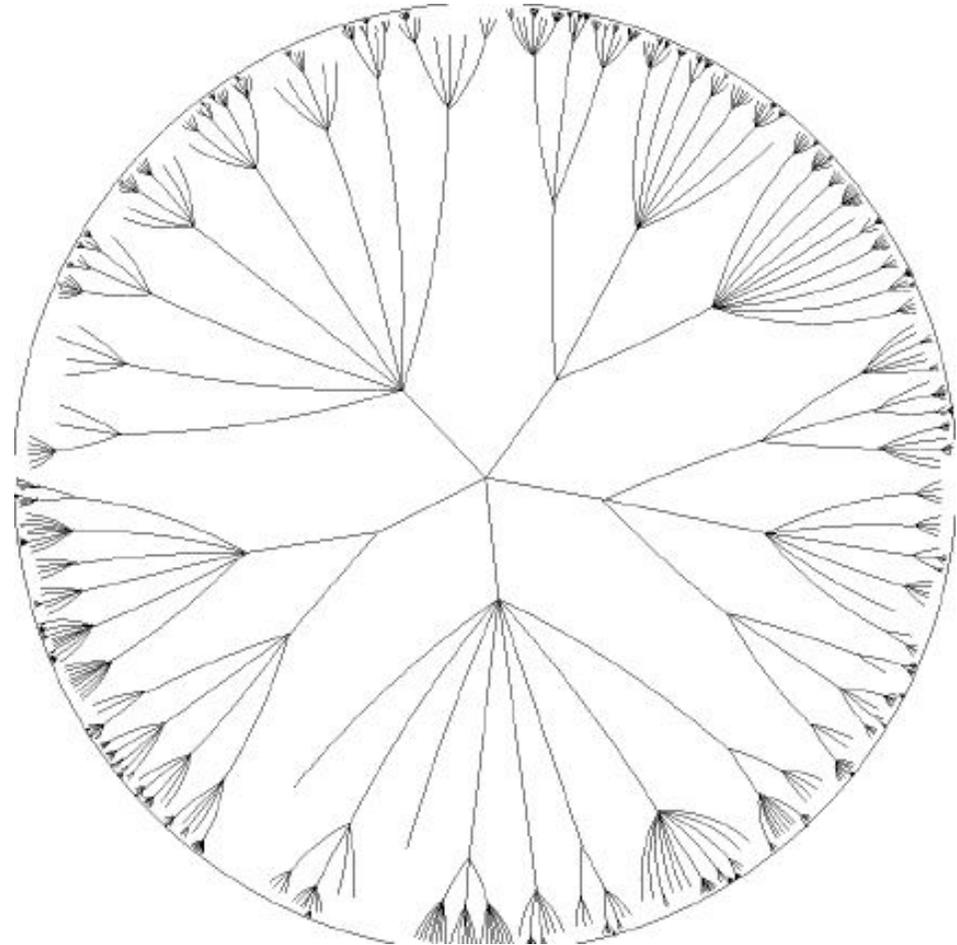
librairie treemap de B. Fry
pour Processing

Arbres hyperboliques (Lamping & Rao, 1995)

Inspiré d'Escher



<http://www.mcescher.com/Gallery/recogn-bmp/LW436.jpg>



http://www.infovis-wiki.net/index.php?title=Image:Hypertree_original.jpg

1004 sommets, distrib. Poissonienne du nbre de fils

« Afficher tous les résultats de recherche pour hyperbolic trees »



... Abb. 11b: Hyperbolic Trees (2) ... Abb. 11a: Hyperbolic Trees (1)

385 x 395 - 10 ko - gif
coli.lili.uni-bielefeld.de



411 x 437 - 12 ko - gif
coli.lili.uni-bielefeld.de

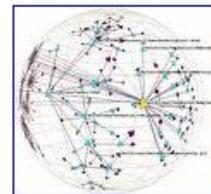
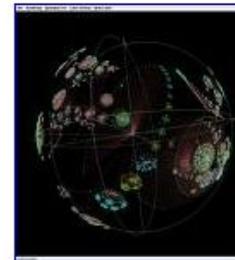
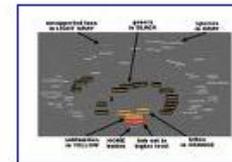


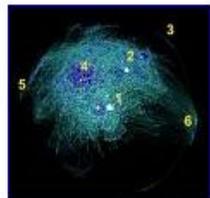
Figure 2-15: Hyperbolic tree.
336 x 308 - 50 ko - gif
www3.sympatico.ca



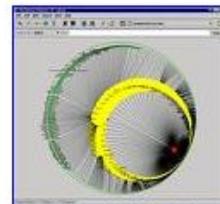
Hyperbolic geometry: Spectacular
888 x 964 - 198 ko - png
www.infovis.net



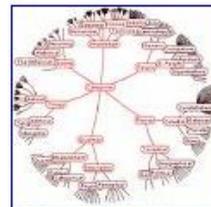
CGDP - HYPERBOLIC TREE
KEY
600 x 404 - 31 ko - gif
www.flmnh.ufl.edu



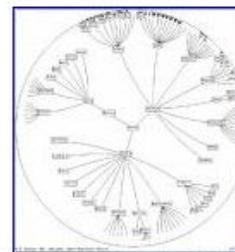
... are two more hyperbolic tree
300 x 288 - 111 ko - jpg
dd.dynamicdiagrams.com



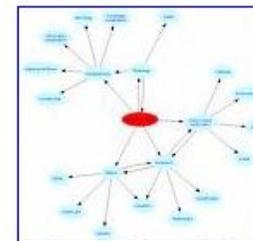
... Eye or Hyperbolic Tree Viewer
is ...
400 x 368 - 58 ko - gif
www.sorice.com



Hyperbolic Tree
350 x 339 - 76 ko - png
vw.indiana.edu



Tree Text: Hyperbolic Tree
729 x 743 - 174 ko - jpg
www.itl.nist.gov



... zum Begriff "Hyperbolic Tree"
864 x 804 - 16 ko - png
beat.doebe.li

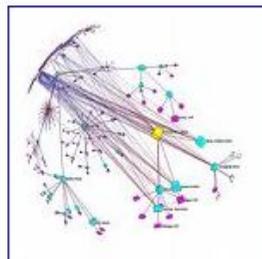
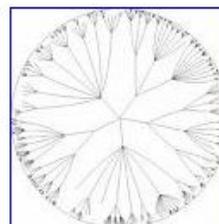


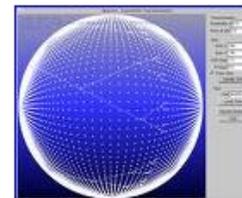
Figure 3.19: Non-tree links



Hyperbolic trees - InfoVis:Wiki



an original hyperbolic tree with



Hyperbolic Tree Visualization

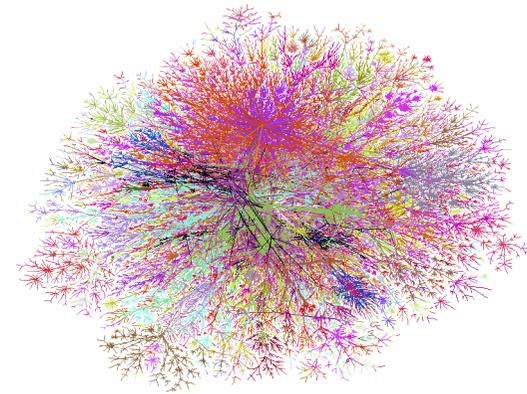


We will use the hyperbolic tree

5. Les graphes généraux

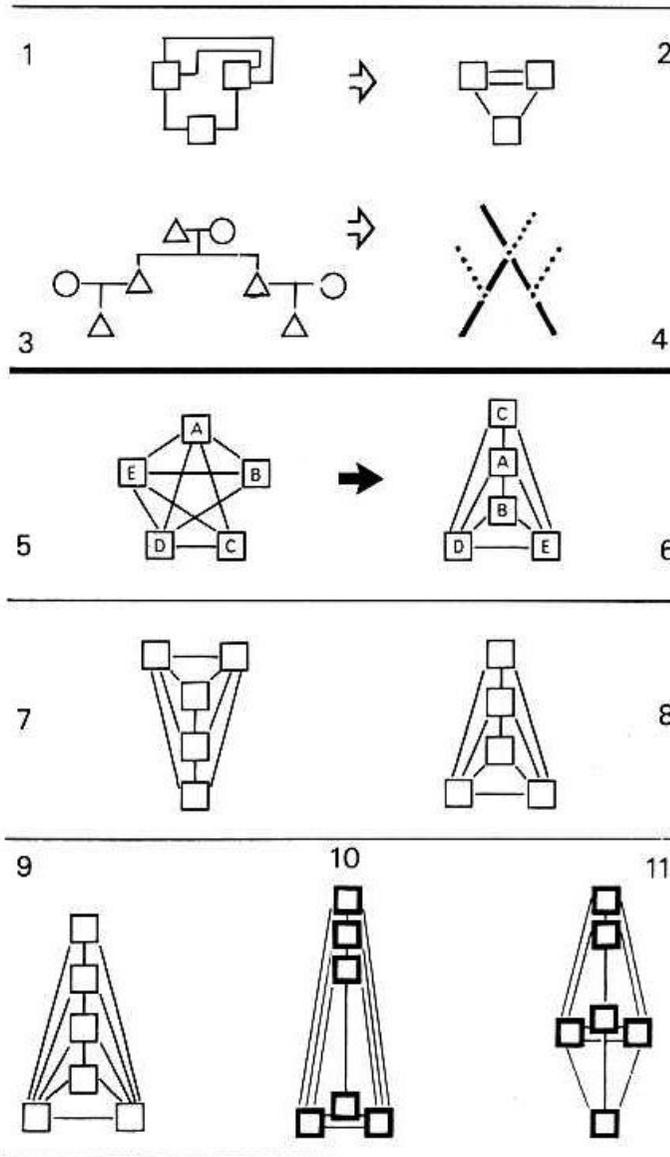


[wikipedia – article Ramen]



(image Lumeta
vue cours #1)

Dessiner un graphe ?



Simplicité
du dessin

TRANSFORMATION

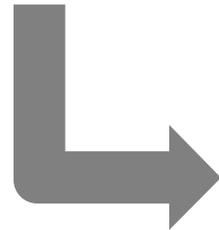
Simplicité de
disposition

Ordre significatif

Groupements
significatifs

[Bertin2]

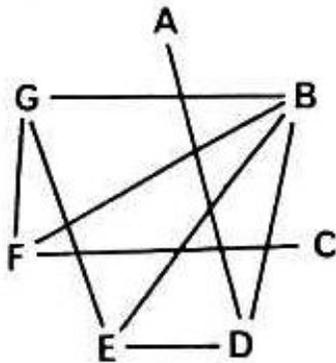
Harry Beck et le plan du métro de Londres (1933)



Dessin automatisé

Méthode semi-manuelle (?) de Bertin

19



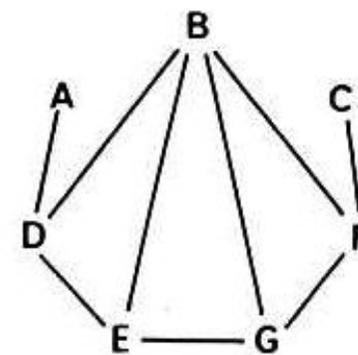
20

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| A | A | | | ● | | | |
| B | | B | | ● | ● | ● | ● |
| C | | | C | | | ● | |
| D | ● | ● | | D | ● | | |
| E | | ● | | ● | E | | ● |
| F | | ● | ● | | | F | ● |
| G | | ● | | | ● | ● | G |

21

| | A | D | E | B | G | F | C |
|---|---|---|---|---|---|---|---|
| A | A | ● | | | | | |
| D | ● | D | ● | ● | | | |
| E | | ● | E | ● | ● | | |
| B | | ● | ● | B | ● | ● | |
| G | | | ● | ● | G | ● | |
| F | | | | ● | ● | F | ● |
| C | | | | | | ● | C |

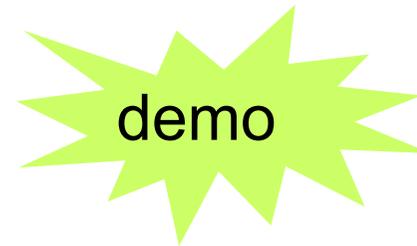
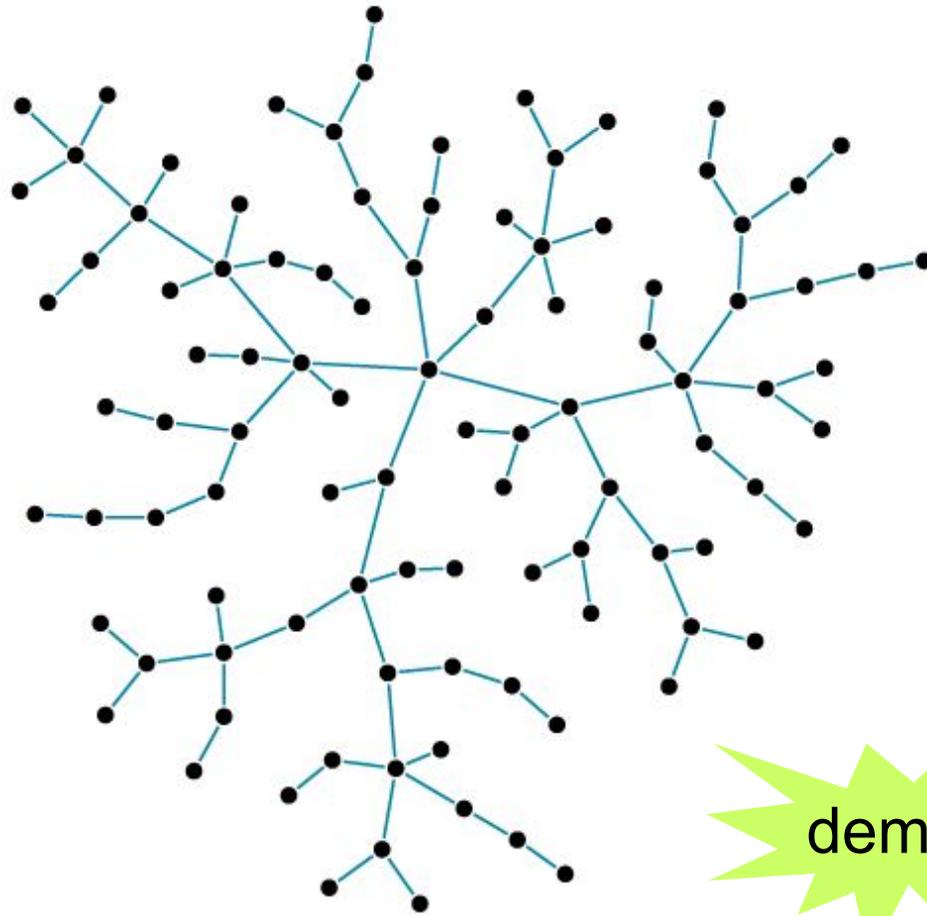
22



Depuis : nombreux algorithmes

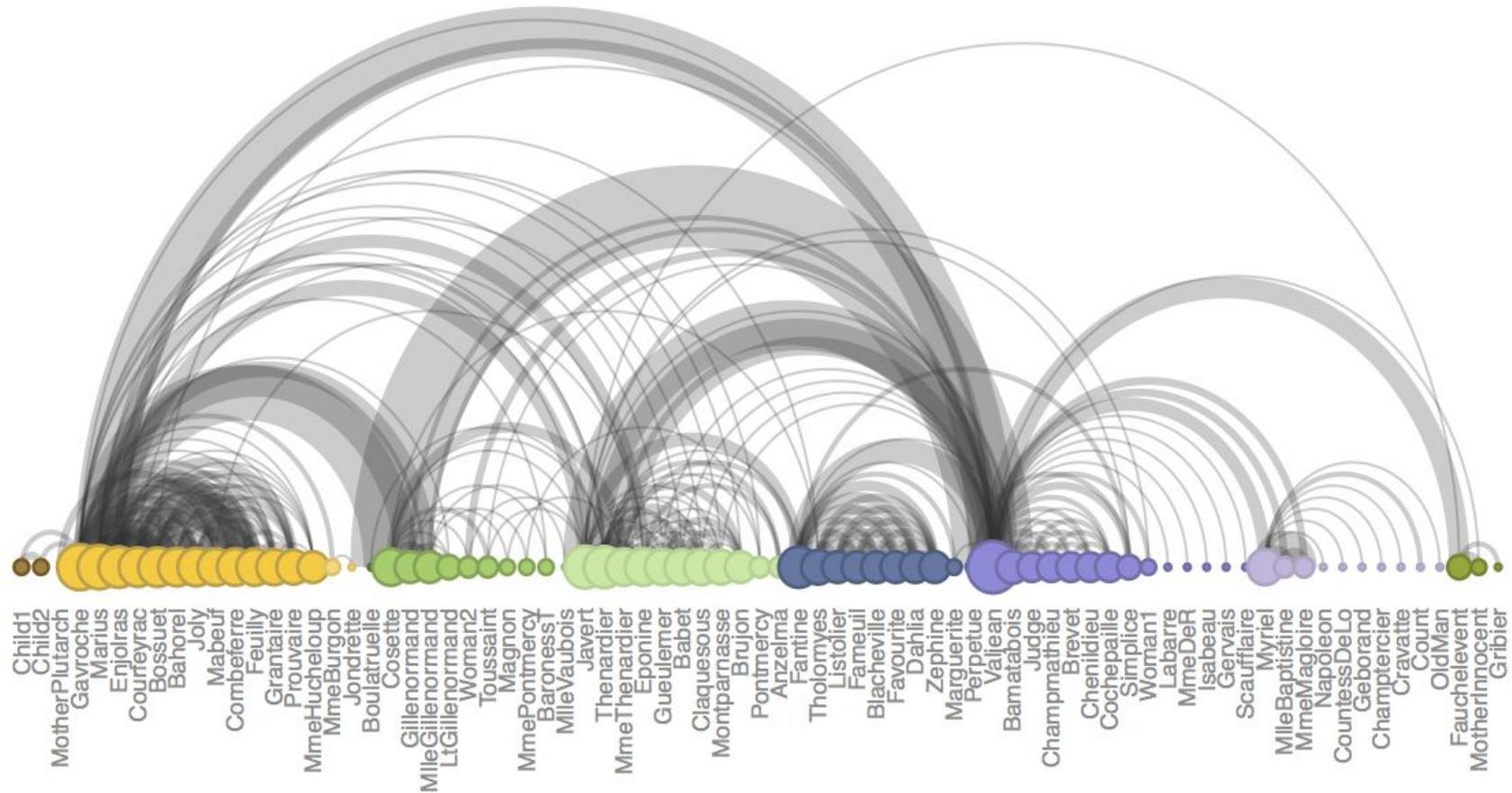
pour une revue : http://en.wikipedia.org/wiki/Graph_drawing

Exemple extrait de "Design generatif" (prog. M_6_1_03)



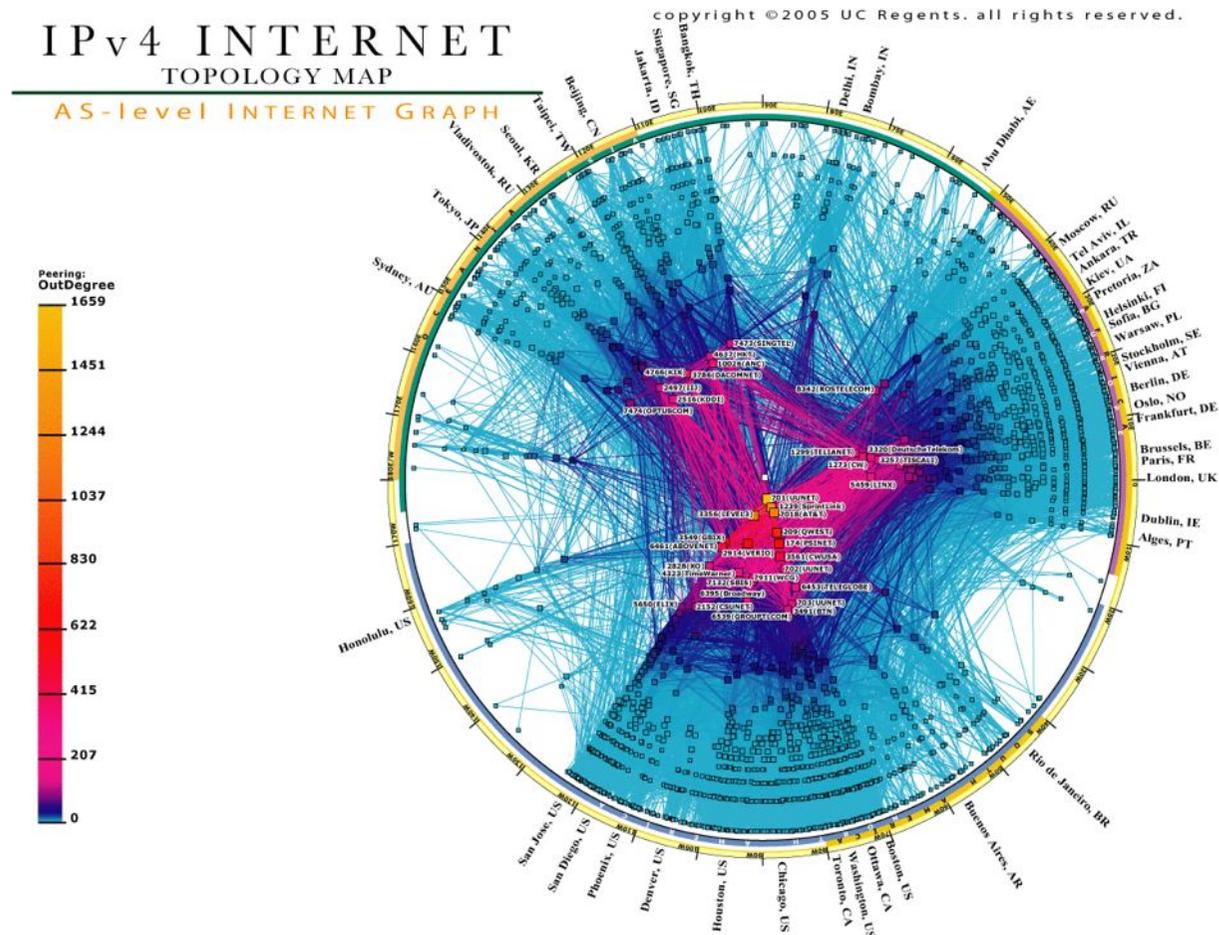
Représentations linéaires

"arc diagrams"



<http://gastonsanchez.com/blog/got-plot/how-to/2013/02/02/Arc-Diagrams-in-R-Les-Miserables.html>

Représentations radiales



CAIDA : routage dans l'internet

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Circos is back for 3rd year at [2012 Bioinformatics and Comparative Genome Analysis](#) course by the Pasteur Institute—May 9

Custom Search x

CIRCOS, LUNG CANCER AND SMOKING

Imielinski *et al.* visualize mutations in the exome and genome sequences of 183 lung adenocarcinomas to reveal recurrent somatic mutations in the splicing factor gene U2AF1 and RBM10 and ARID1A, as well as EGFR and SIK2. Grouping the data revealed clusters that correlated with smoking history.

Imielinski M, Berger AH, Hammerman PS *et al.* (2012) [Mapping the hallmarks of lung adenocarcinoma with massively parallel sequencing](#) *Cell* 150:1107–1120.

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WHAT IS CIRCOS?

CIRCULAR VISUALIZATION

Circos is a software package for [visualizing data and information](#). It visualizes data in a [circular layout](#) — this makes Circos ideal for exploring relationships between objects or positions. There are [other reasons](#) why a circular layout is advantageous, not the least being the fact that it is attractive.

Circos is ideal for creating publication-quality infographics and illustrations with a high [data-to-ink ratio](#), richly layered data and pleasant symmetries. You have fine control each element in the figure to tailor its focus points and detail to your audience.

Circular genome and data visualization with Circos (950 x 234)

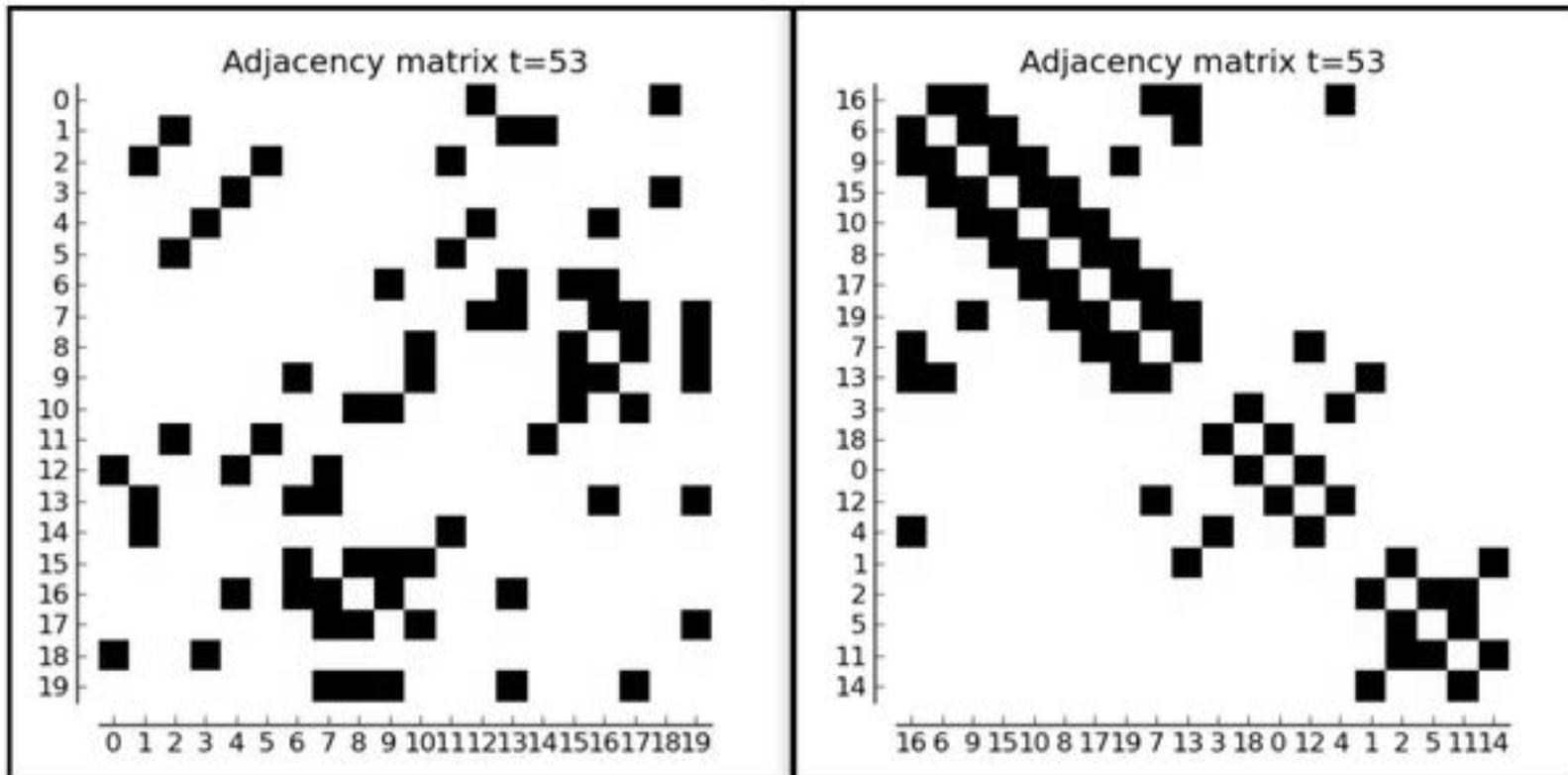
▲ Images created with Circos, illustrating links, ribbons, tiles and a variety of 2D data tracks. If it's round, Circos can probably do it ([more images](#)).

Circos is flexible. Although originally designed for [visualizing genomic data](#), it can create figures from [data in any field](#). If you have data that describes relationships or multi-layered annotations of one or more scales, Circos is for you.

Circos can be automated. It is controlled by plain-text configuration files, which makes it easily incorporated into data acquisition, analysis and reporting pipelines (a data pipeline is a multi-step process in which data is analyzed by multiple and typically independent tools, each passing their output as the input to the next step).

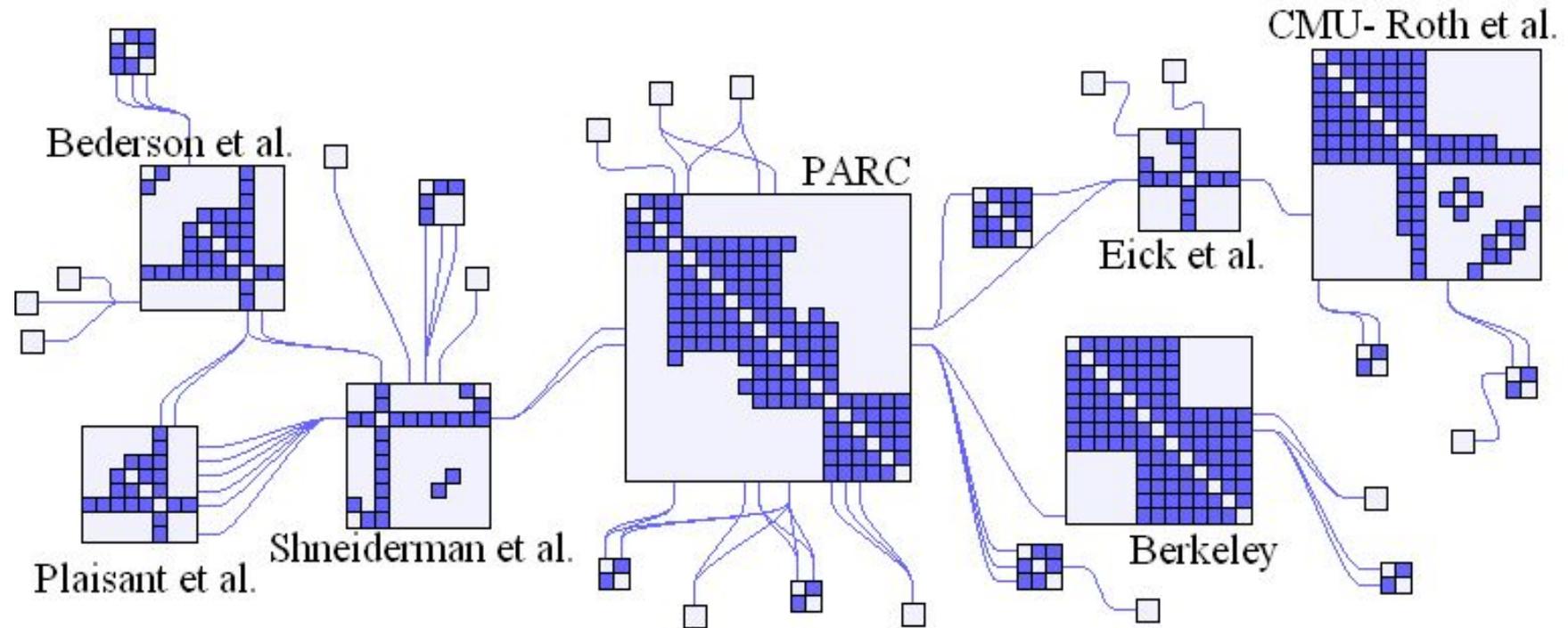
un logiciel <http://circos.ca>

Matrice d'adjacence



<https://twitter.com/stefvandanelzen/status/520147126102556672>

Approche mixte (graphe-matrice)



Equipe AVIZ de l'INRIA

<http://www.aviz.fr/wiki/pmwiki.php/Research/Nodetrix>

Outils logiciels

The image shows a screenshot of the Graphviz website and a presentation slide for Gephi. The website header includes the Graphviz logo, the title "Graphviz - Graph Visualization Software", the tagline "Envisioning connections", and navigation links for "Forums" and "Contact Us". A search bar is also present. The main content area features a "Welcome to Graphviz" message with a list of available translations (Romanian, Russian, Serbo-Croatian, Bulgarian) and a "What is Graphviz?" section explaining its use in various technical domains. A diagram illustrates a graph structure with nodes a0, a1, b0, b1 and a start node. The presentation slide, titled "Gephi", lists key features: it is an open-source project started by students at UTC, a visualization and analysis tool, written in Java and maintained by a large community, and available at http://gephi.org. The slide also includes the logo of le cnam.

Graphviz - Graph Visualization Software
Envisioning connections

Forums | Contact Us

Search this site: Search

Graphviz Site Changes
Due to organizational changes, the Graphviz web site will see some modifications in the near future. In particular, it will probably no longer provide binary packages for Windows and Macs. The latter can be obtained via Macports or Home Brew. If someone wants to set up Appveyor for Windows, we would be grateful.

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• Credits
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• FAQ
• All Users

User login
Username: *

Password: *

Graphviz

Welcome to Graphviz
Available translations: [Romanian](#), [Russian](#), [Russian \(more natural?\)](#), [Serbo-Croatian](#), [Bulgarian Home](#) and [About](#)

What is Graphviz?
Graphviz is open source graph visualization software. Graph visualization is a way of representing structural information as diagrams of abstract graphs and networks. It has important applications in networking, bioinformatics, software engineering, database and web design, machine learning, and in visual interfaces for other technical domains.

```
graph TD
    start{start} --> a0((a0))
    start --> b0((b0))
    a0 --> a1((a1))
    b0 --> b1((b1))
```

Active forum topics

- I need a direction is someone could help
- compilation issue on slackware 14.1
- graphviz linking to qt
- Curved arrows
- compiling cdt and cgraph on windows as static libraries

[more](#)

New forum topics

- I need a direction is someone could help
- graphviz linking to qt
- compilation issue on slackware 14.1
- compiling cdt and cgraph on windows as static libraries
- Curved arrows

Gephi

- Projet open source démarré par des étudiants à UTC
- Outil de visualisation et d'analyse
- Écrit en Java, maintenu par une communauté large (développeurs seuls, entreprises, universités, etc.)
- <http://gephi.org>

le cnam

et Gephi (cf cours sur la fouille de graphe)