

Introduction to Semiology of Graphics

Learning Objectives

- What are components of a graphic?
- How to create visual representations?

Semiology of Graphics



- Jacques Bertin (1918 - 2010)
- French cartographer
- Rules to map
 - Information
 - Image

Bertin's consideration

- printable, on white paper

- visible at a glance

- reading distance of book or atlas

- normal and constant lighting

- readily available graphic means

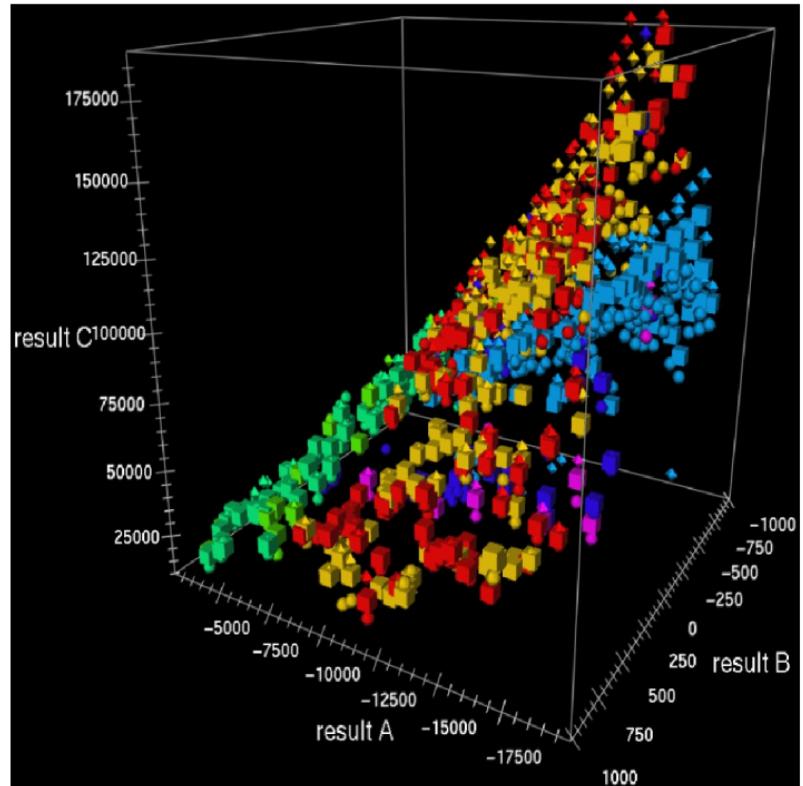
Why do we learn Semiology of Graphics

Semiology – an approach of graphic representation

Three functions of graphic representation:

- Recording information
- Communicating information
- Processing information

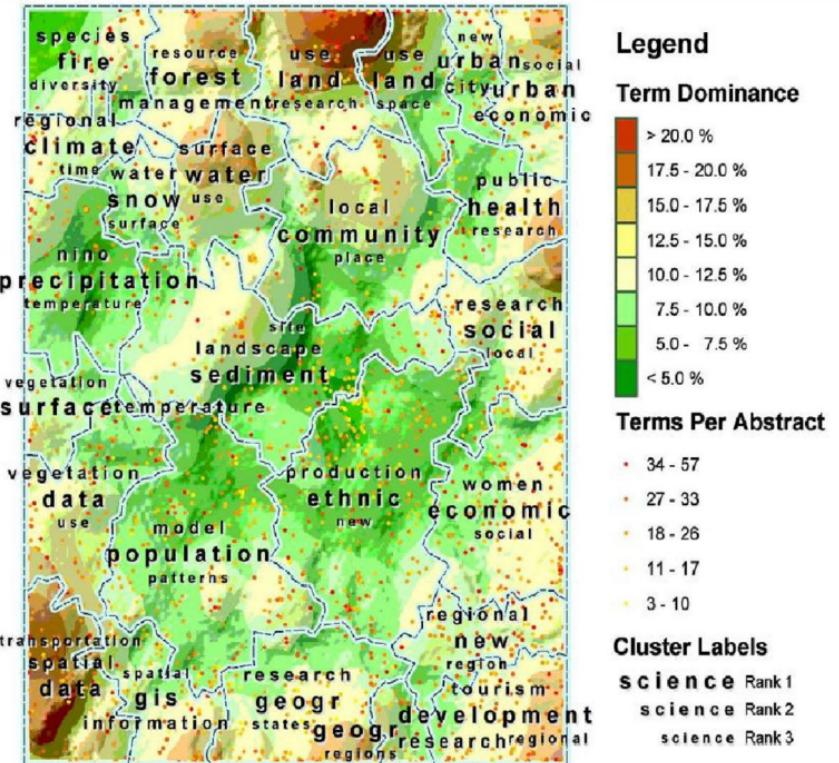
Example of visualisation (I)



Example of visualisation (II)

temporal
↑
color
shape





Example of visualisation (III)

boundary → cluster

Current Visualisation Production

Drawing Applications (Graphics Designers)

- Photoshop, Illustrator, etc.

Graphics Libraries (Graphics Programmers)

- OpenGL, WebGL, etc.

Visualisation libraries

- D3, Matplotlib

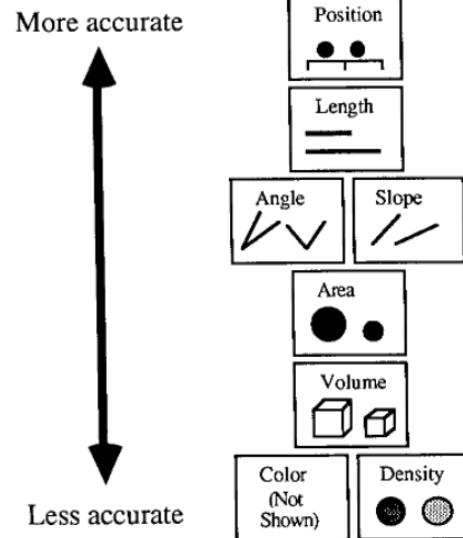
Integrated environment

- Tableau

One of the Influences of Bertin's SoG

Jock Mckinlay

- Pioneered automatic design of graphical presentations of relational information
- R&D at Tableau



Mackinlay, J. (1986). Automating the design of graphical presentations of relational information. *ACM Trans. Graph.*, 5(2), 110–141.
<https://doi.org/10.1145/22949.22950>

The Plane: Implantation

The Plane

- Continuous
- Homogeneous
- Has two dimensions

eg. paper

Implantation

Point

- represents a location on the plane that has no theoretical length or area
- Position of an airplane, the “corner” of a forest etc

Line

- signifies a phenomenon on the plane which has measurable length but no area
- Boundary of continent, bus route etc

Area

- signifies something on the plane that has a measurable size.
- Island/ lake /land on a map

The Plane: Signfield of Graphics

Recall...

Quality of Attribute (Computer Programming)

- Category data
 - Nominal scale
- Integer data
 - Ordinal scale
- Real-number data
 - Interval & ratio scale

Signfields in Graphics, Part I

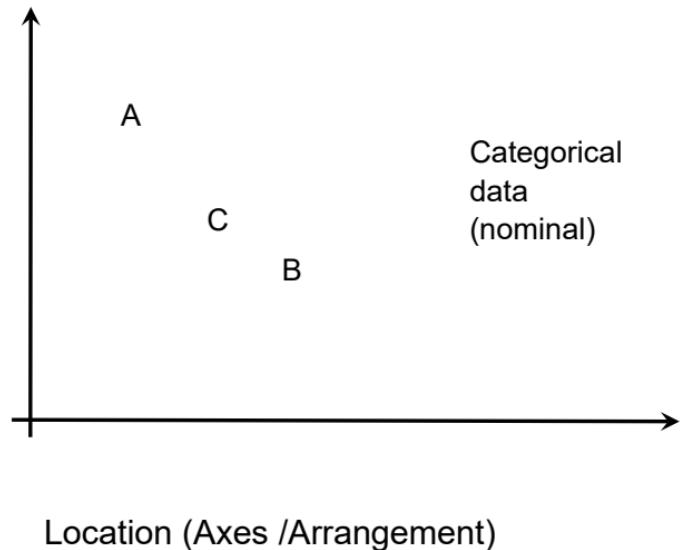
“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



Location (Axes /Arrangement)

Signfields in Graphics, Part II

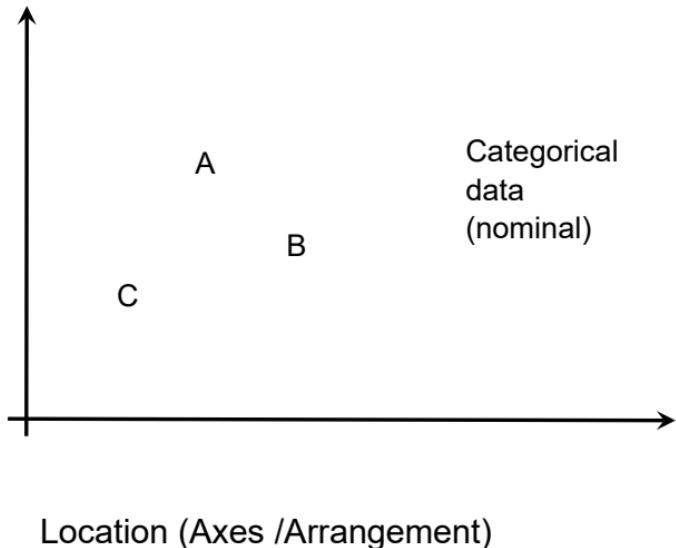
“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



Signfields in Graphics, Part III

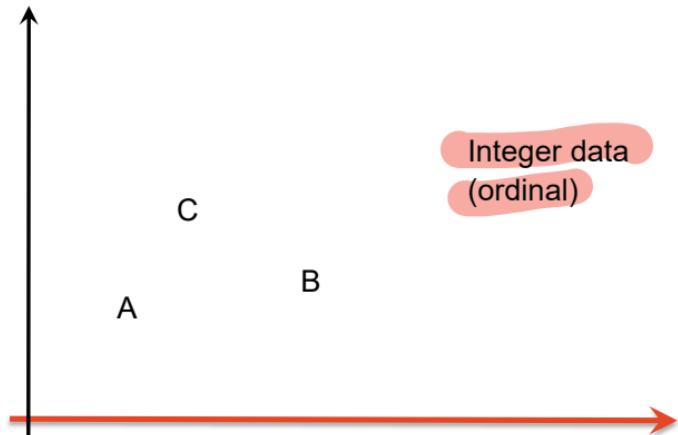
“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin

categorical
if label is different, then they are different
order doesn't matter
location



Signfields in Graphics, Part IV

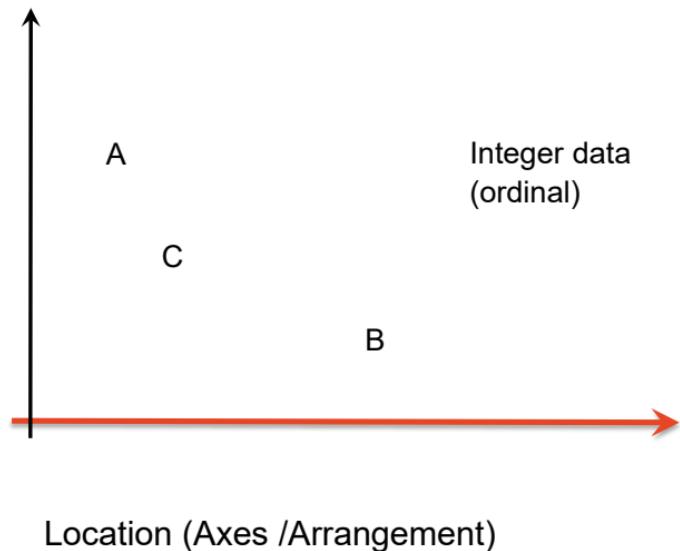
“Resemblance, **order** and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



Location (Axes /Arrangement)

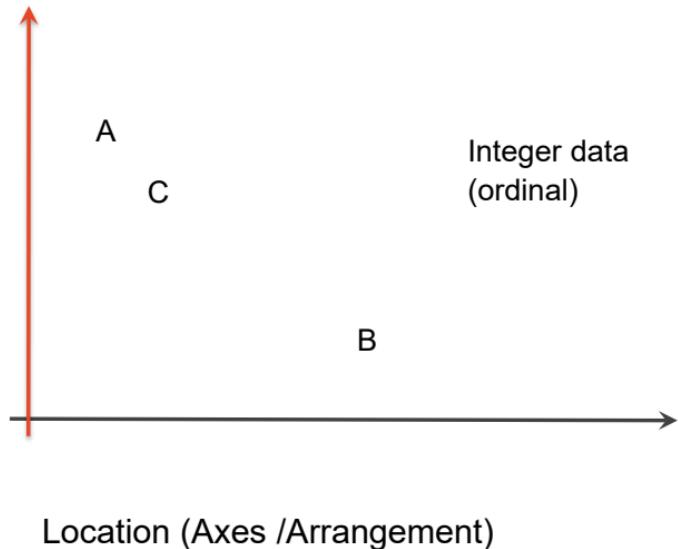
Signfields in Graphics, Part V

“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



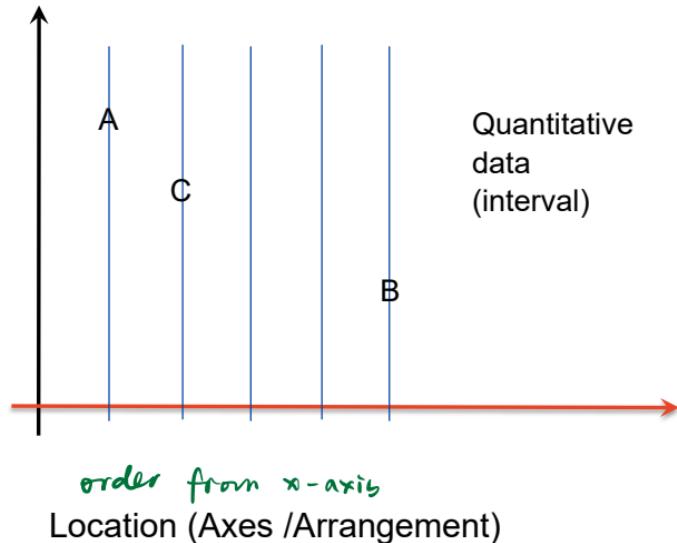
Signfields in Graphics, Part VI

“Resemblance, **order** and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



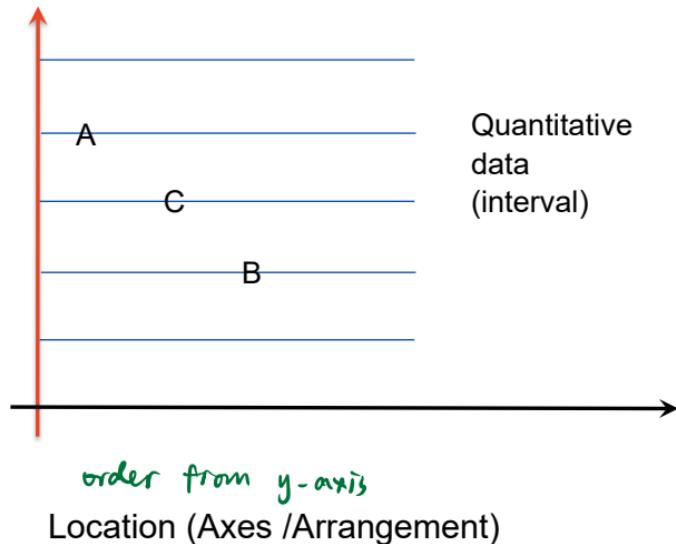
Signfields in Graphics, Part VII

“Resemblance, **order** and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



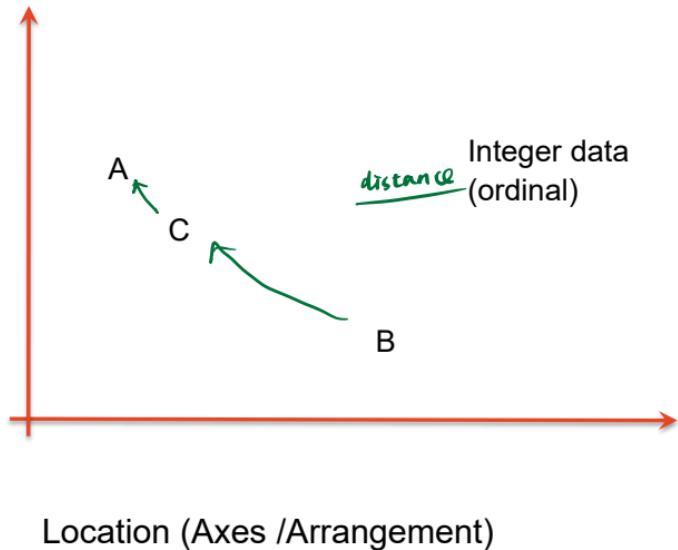
Signfields in Graphics, Part VIII

“Resemblance, **order** and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



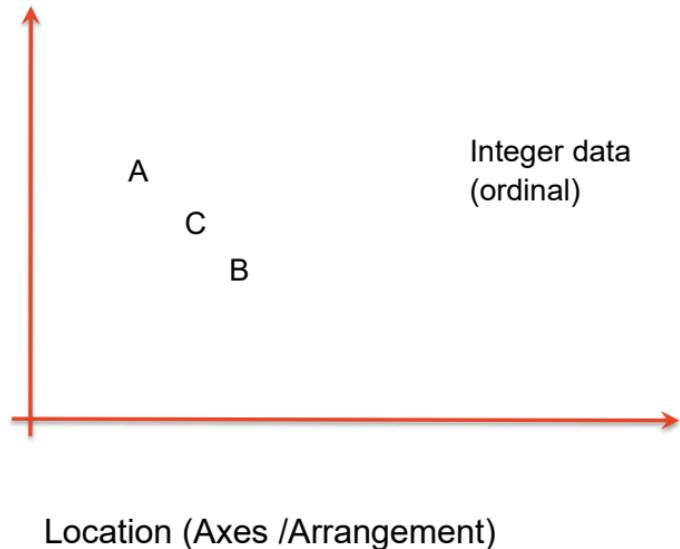
Signfields in Graphics, Part IX

“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



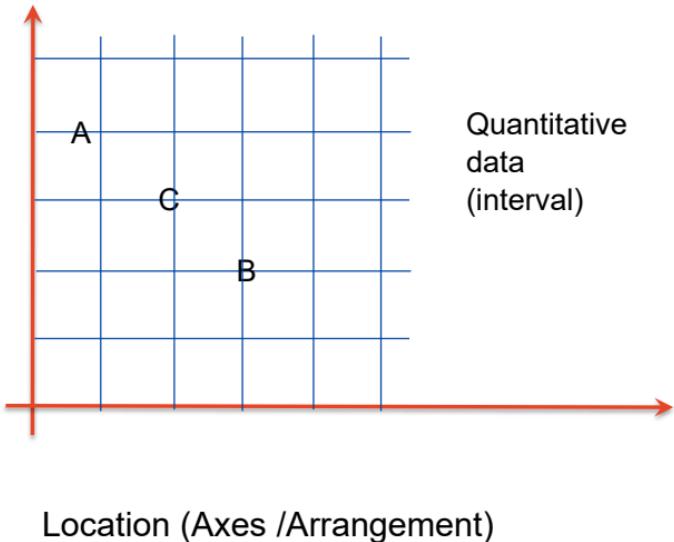
Signfields in Graphics, Part X

“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



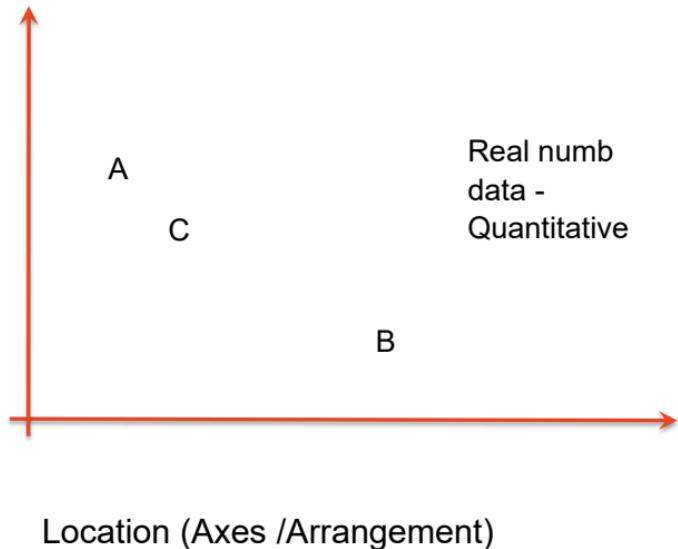
Signfields in Graphics, Part XI

“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



Signfields in Graphics, Part XII

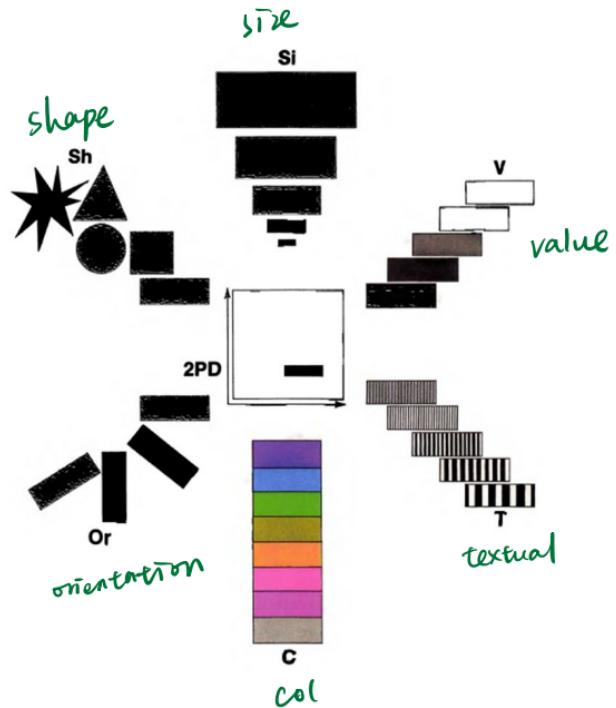
“Resemblance, order and proportional are the three signfields in graphics. These signfields are transcribed by visual variables having the same signifying properties” - Bertin



Visual Variables

Visual / Retinal Variables

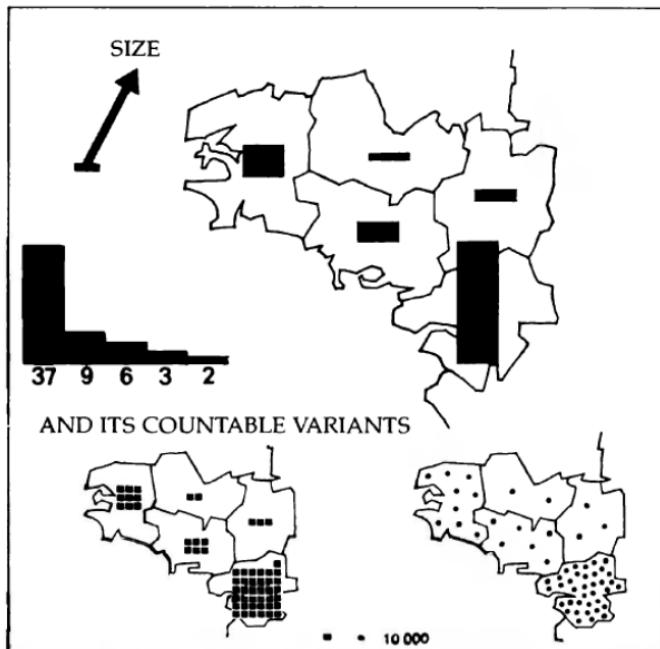
- necessary in all graphic problems involving three or more components, when the two dimensions of the plane are already being utilized.



Size

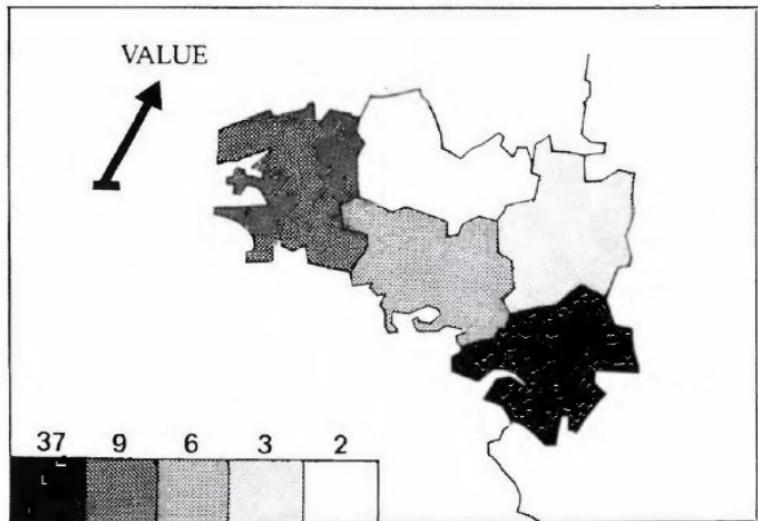
Changes in

- height of a column (length)
- area of a sign
- number of equal signs (repetition)



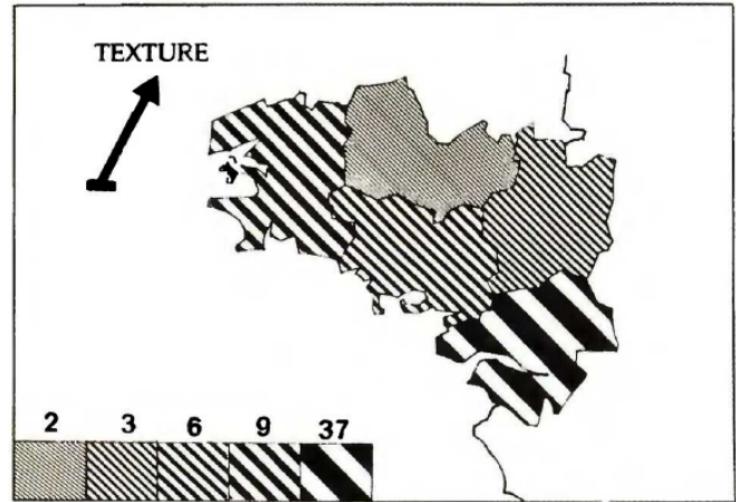
Value (Lightness)

- the various degrees between black and white
- Changes from light to dark or vice versa



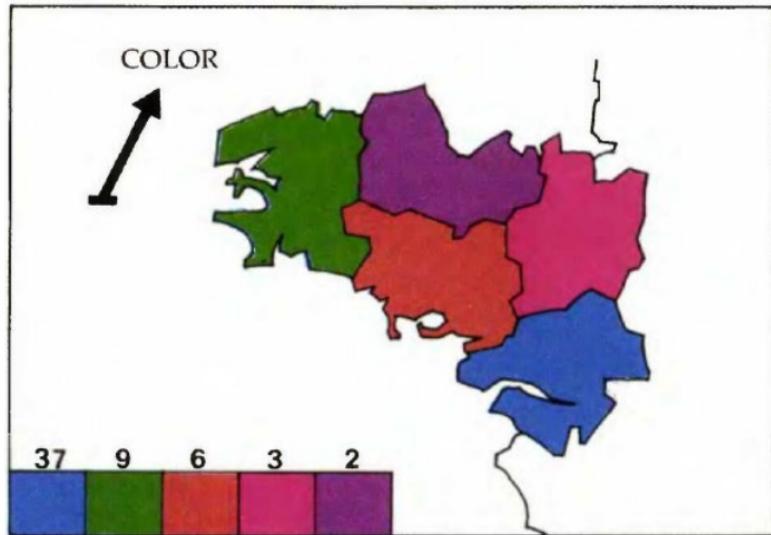
Texture (Spacing)

- Changes in fineness or coarseness of the constituents of an area having a given value



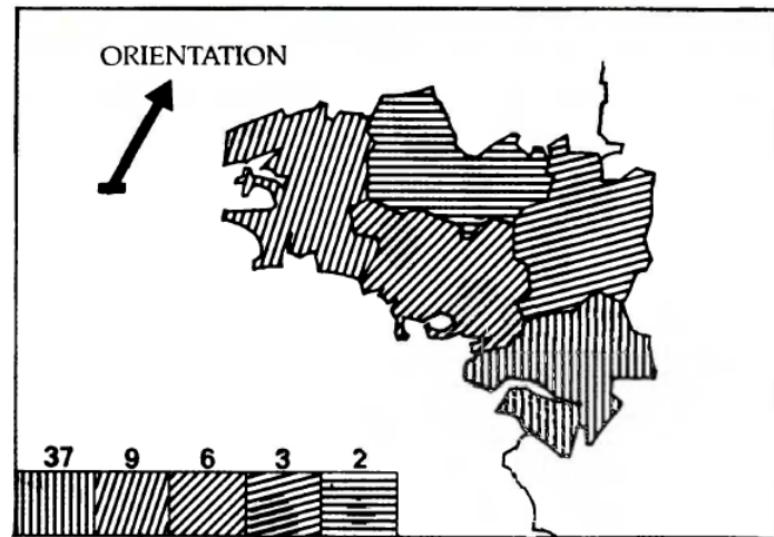
Colour (hue)

- Changes in coloured sensation at equal value



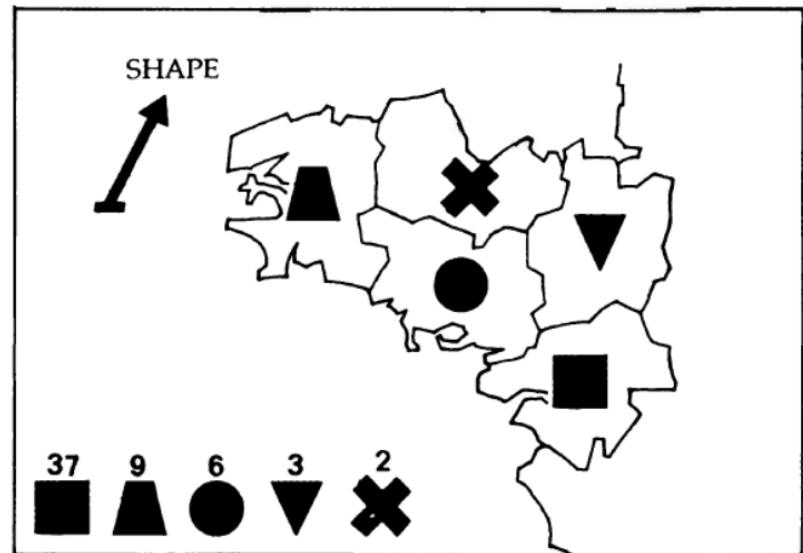
Orientation

- various orientations of a line or line pattern
- ranging from the vertical to the horizontal in a distinct direction



Shape

- A mark with a fixed size can have infinite number of shapes



Other visual variables?

- Location
- Saturation or Intensity
- Focus or Crispness
- Resolution
- Transparency

And more

Level of Organization

Levels of organisation

- 1) Associative (\equiv)
- 2) Selective (\neq)
- 3) Ordered (O)
- 4) Quantitative (Q)

LEVELS OF ORGANIZATION
OF THE VISUAL VARIABLES

PLANAR DIMENSIONS	\equiv	\neq	O	Q
SIZE	\neq	\neq	O	Q
VALUE	\neq	\neq	O	
TEXTURE	\equiv	\neq	O	
COLOR	\equiv	\neq		
ORIENTATION	\equiv	\neq		P & L Implantations
SHAPE	\equiv			

Associative perception (\equiv)

“Marks can be perceived as **SIMILAR**.”

1) Test

A series of undifferentiated points forming a uniform area, can immediately reconstruct the uniformity of the area, despite a given visual variation

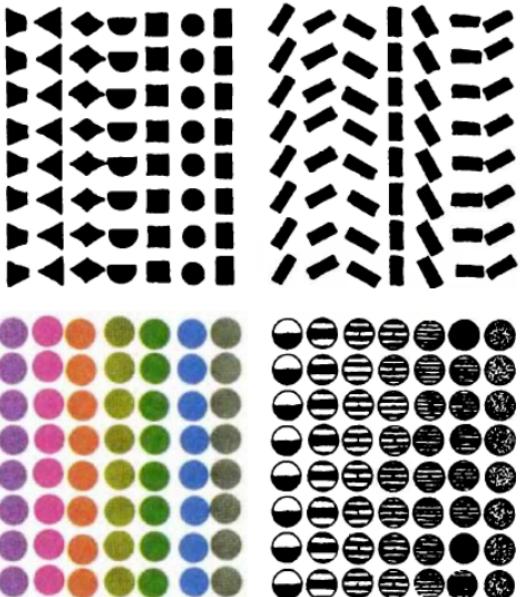
2) Visibility

All signs appear to have same power – same visual “weight” or visibility

3) Retinal variables

Shape, Orientation, Texture and Colour

* For all P, L and A implantations



Selective perception (\neq)

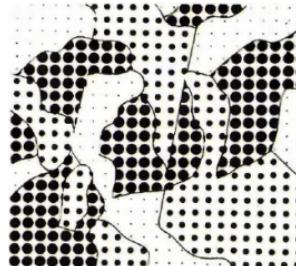
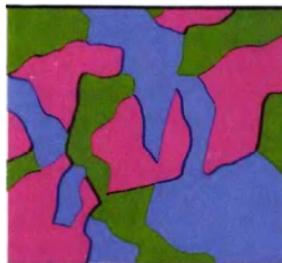
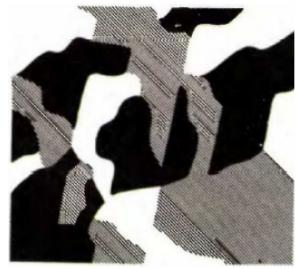
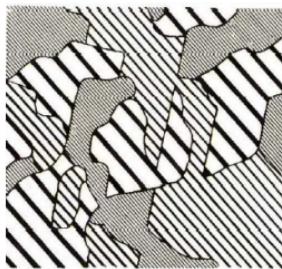
“Marks are be perceived as DIFFERENT.”

1) Test

Able to isolate all the elements of this category, disregard all the other signs, and perceive the image formed by the given category.

2) Retinal variables

Orientation (P and L only); Texture, Value, Size and Colour (P, L and A)



Ordered (O)

Marks can be perceived in a sequence.

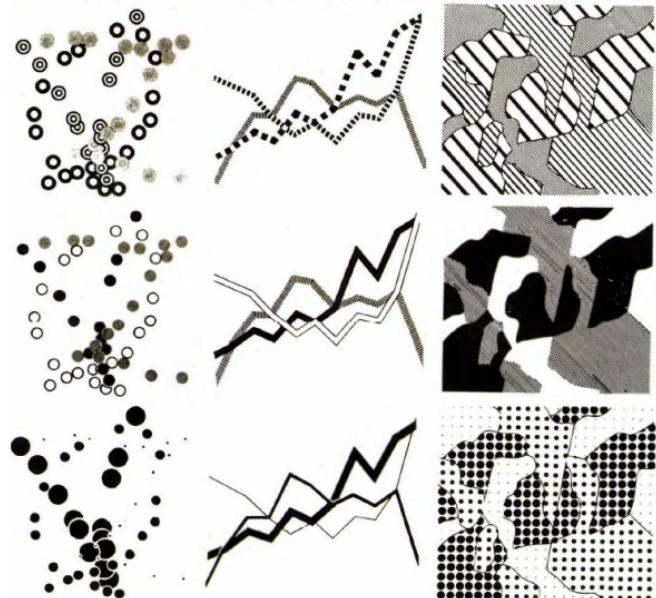
1) Test

- Not necessary to consult the legend to be able to order the categories.
- Can immediately reestablish the universal order of the signs for each variable.

2) Retinal variables

Texture (spacing), Value and Size (P, L and A)

small → big
eg



Quantity perception (Q)

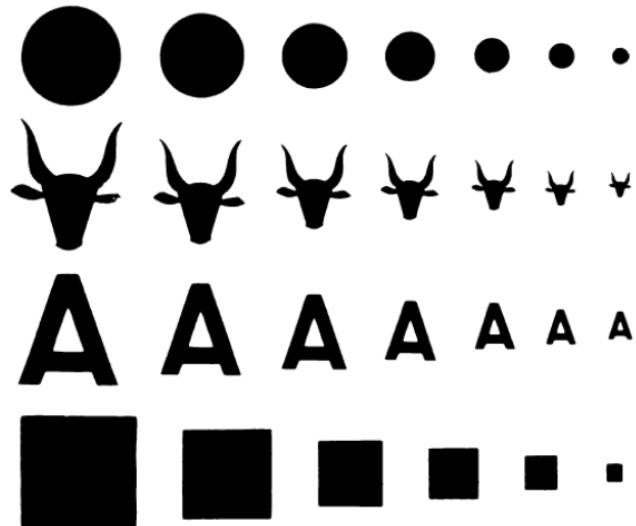
"Marks are perceived as PROPORTIONAL to each other."

1) Test

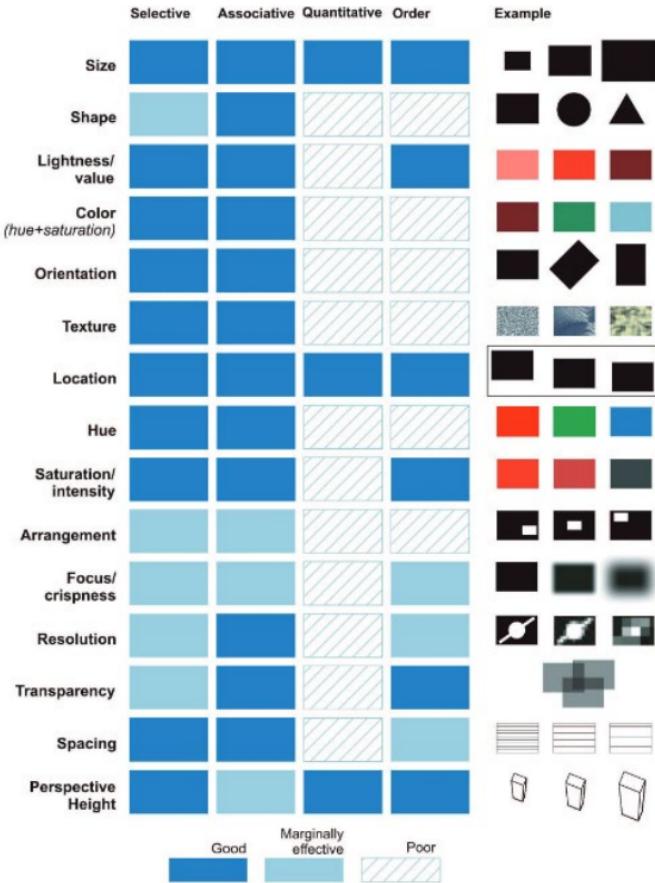
- Numerical ratio between two signs is immediate, necessitates no recourse to the legend
- Represents an accurate approximation but not a precise measurement.

2) Retinal variables

Size (P, L and A)



		LEVEL OF THE RETINAL VARIABLES			
		ASSOCIATION ≡ The marks can be perceived as SIMILAR	SELECTION ≠ The marks are perceived as DIFFERENT, forming families	ORDER ○ The marks are perceived as ORDERED	QUANTITY Q The marks are perceived as PROPORTIONAL to each other
PLANAR DIMENSIONS	SIZE				
	VALUE				
TEXTURE					
COLOR					
ORIENTATION					Conventions leading to the ELEMENTARY READING LEVEL
SHAPE					



Imposition

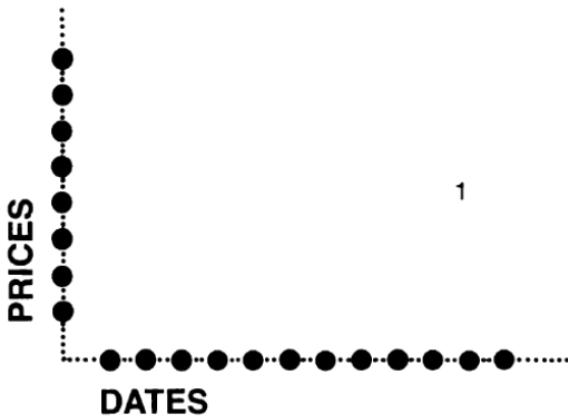
Groups of representation

- Diagrams
- Networks
- Maps
- Symbols

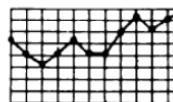
Diagrams

When the correspondences on the plane can be established between

- all the divisions of one component and
- all the divisions of another component



1

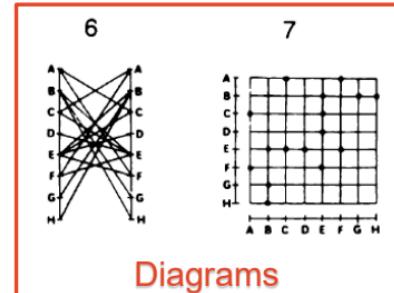
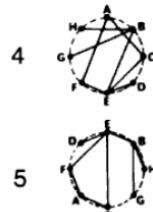
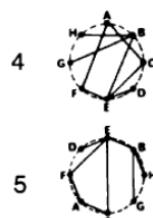
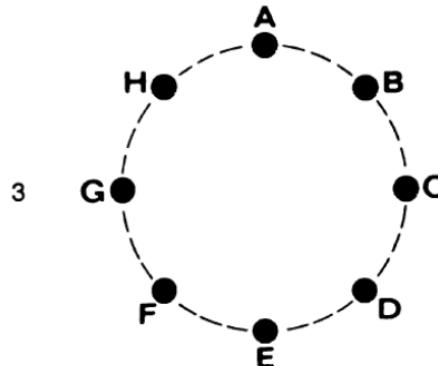


2

Networks

When the correspondences on the plane can be established

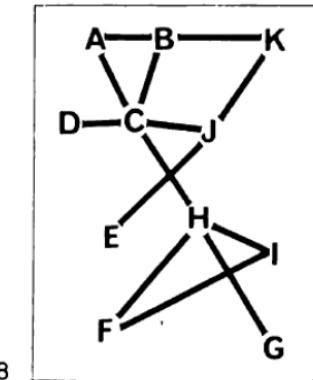
- among all the divisions of the same component



Maps

When the correspondences on the plane can be established

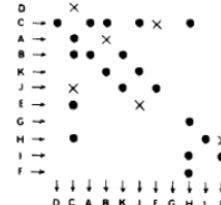
- among all the divisions of the same component
- arranged according to a geographic order



8



9

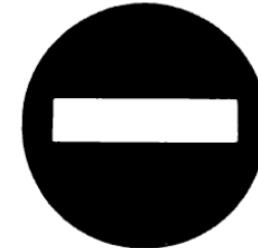


10

Diagram

Symbols

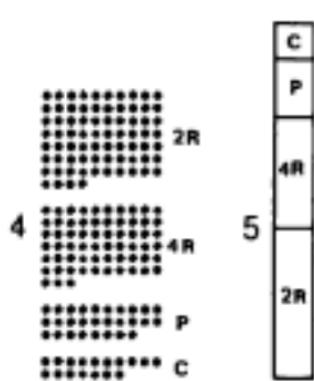
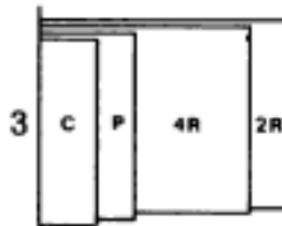
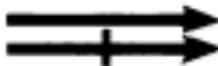
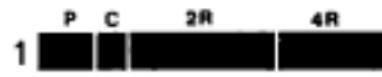
When the correspondence is not established on the plane, but between a single element of the plane and the reader



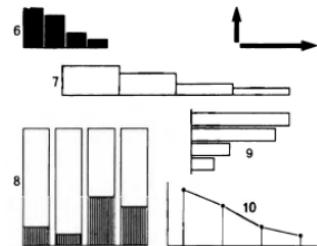
Principal Types of Construction

- Rectilinear
- Orthogonal
- Circular
- Polar

Rectilinear (linear) construction



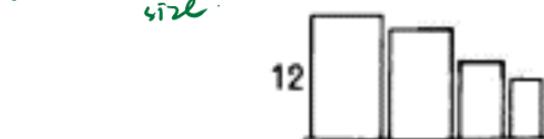
Orthogonal construction



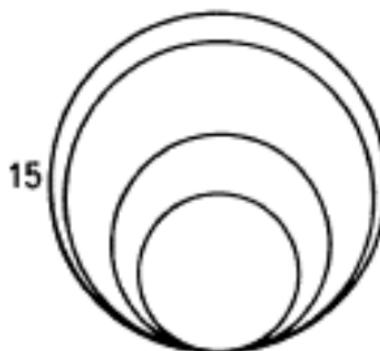
Rectilinear elevation

2 dimensions

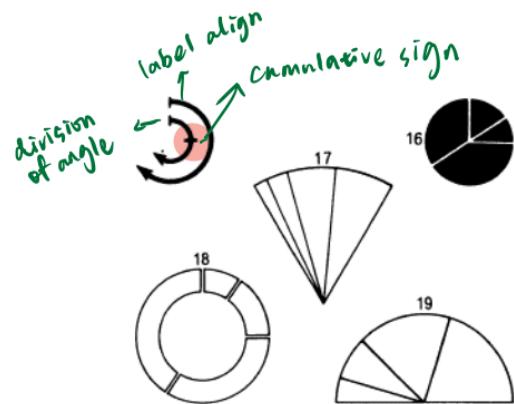
still jump one of plane



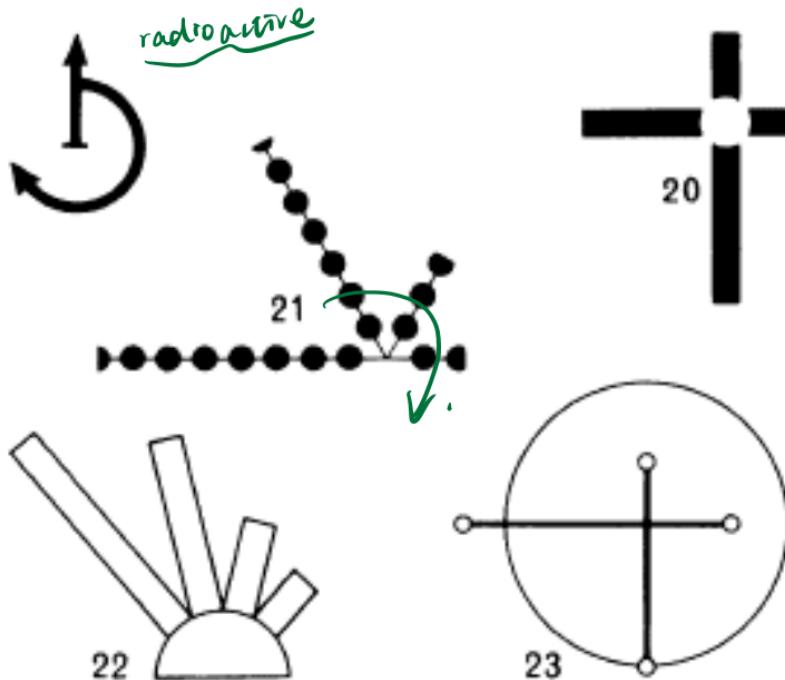
shape align one direction
size change



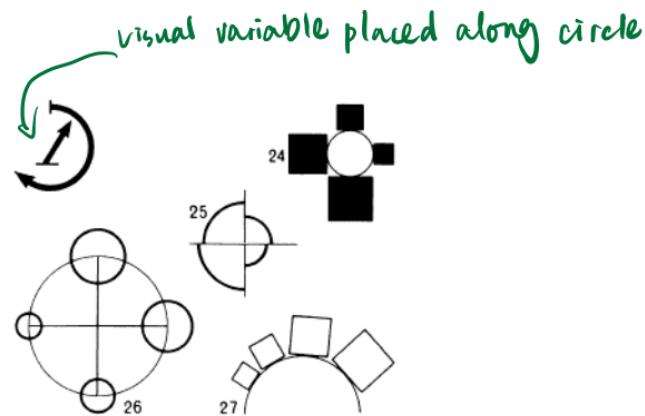
Circular construction



Polar construction



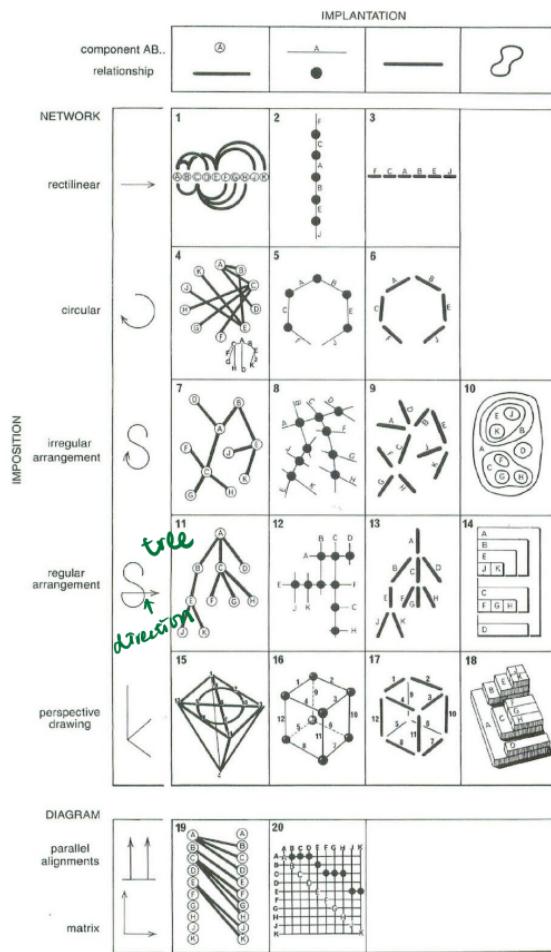
Circular elevation



IMPOSITION

TYPES OF IMPOSITION

	ARRANGEMENT	RECTILINEAR	CIRCULAR	ORTHOGONAL	POLAR
GROUPS OF IMPOSITION					
DIAGRAMS					
NETWORKS	 free, general graph				 pie chart e.g. 2)
MAPS	 geographic map				
SYMBOLS					



Steps to produce a representation

Level of organisation of components

- Associative component
- Qualitative component
- Ordered component
- Quantities

Components and Way to represent them

Level of organisation of component	Symbol used in representation
Component whose elements can all be considered as SIMILAR	\equiv
Qualitative component (DIFFERENTIAL)	\neq
ORDERED component (not reorderable)	O
Quantities	Q or $Q\%$ or $\log Q$
REORDERABLE component, but ordered by quantities	$\xrightarrow{\neq} O_{(Q)}$

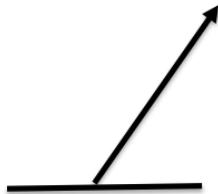
Utilization of dimensions of plane

- Rectilinear utilisation
- Circular utilisation
- Arrangement
- Retinal Variables
- Point, Line, and Area

Retinal Variables

Read as an “elevation” above the plane

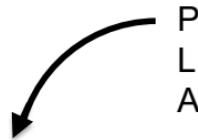
Symbol used:



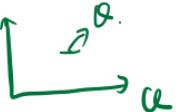
Points, Lines or Areas

Implantations that are not differentiated

Symbol used:



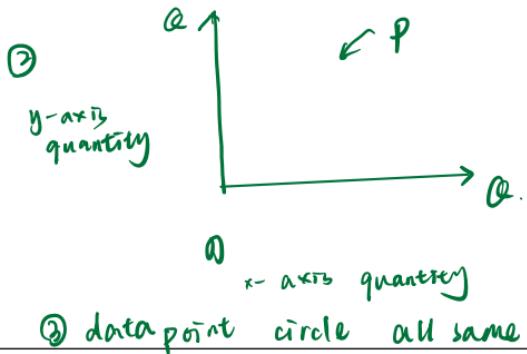
Example 1

if the points have 3rd axis, eg. color 1-10 (quantity)
then  why "Z" = since data is 2 dimensions.

Visualisation:



Representation:



Homogeneous dimension

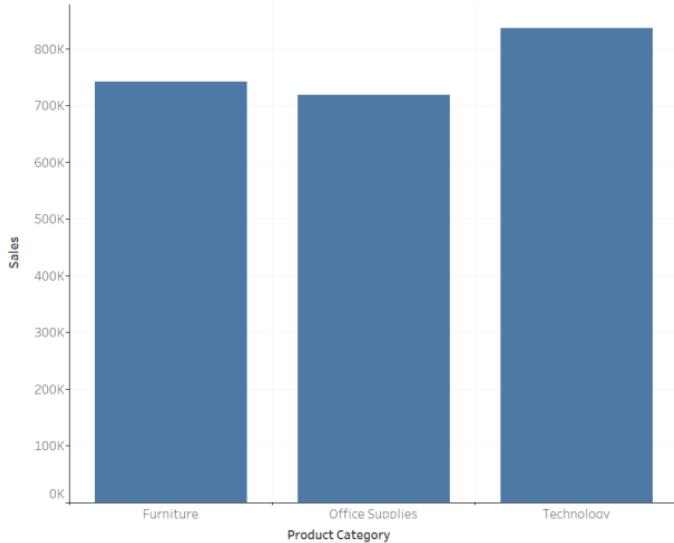
The categories are established once and for all.

Symbol used:

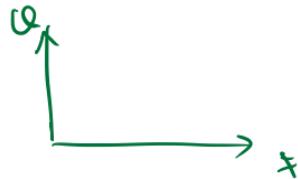


Example 2

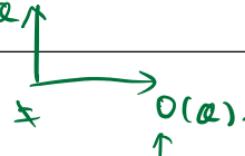
Visualisation:



Representation:



x -axis is differentiated
also not ordered
if ordered $\alpha \uparrow$



Heterogeneous dimension

The categories are repeated several times

Symbol used:



Homogeneous dimension with heterogeneous sub-dimensions

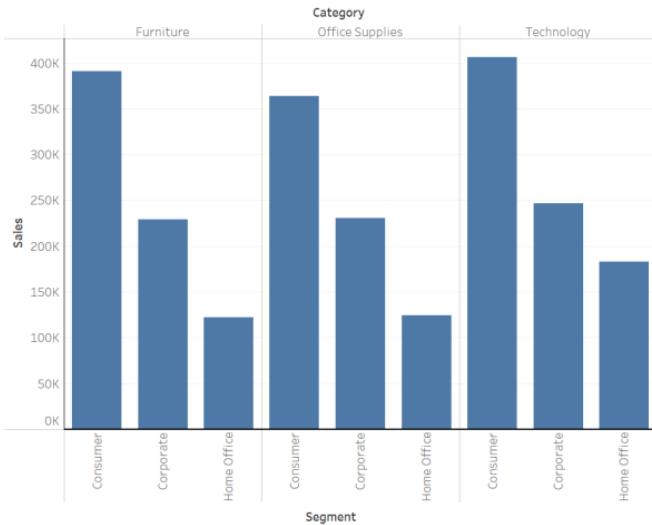
n indicates the number of images or figures

Symbol used:



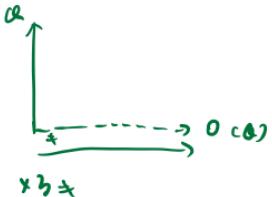
Example 3

Visualisation:



Representation:

y-axis sales quantity
x-axis consumer, corporate, Home office repeated
use --- represents repetition



* need to decide which one is elevation

Cumulated dimension

Quantities are “stacked” together.

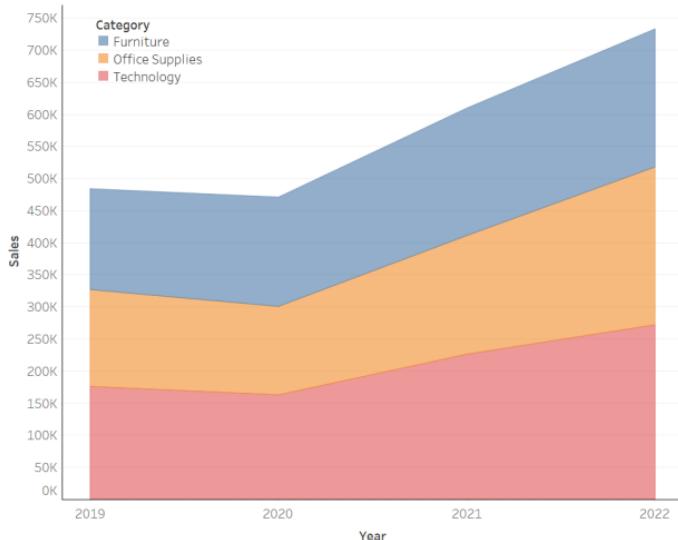
Symbol used:

eg 100% , 360° .



Example 4

Visualisation:

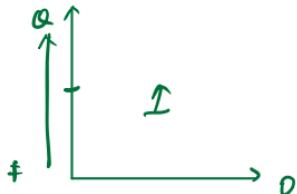


if all square boxes add up to 100% , use 0%.

Representation:

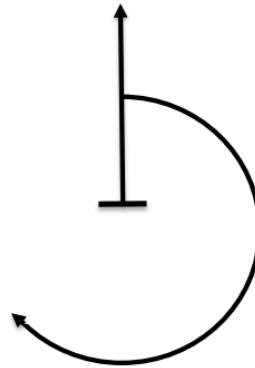
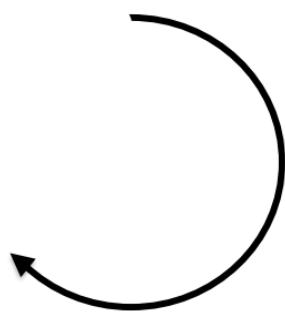
$I = 3^{\text{rd}}$ dimension (color)

#↑ : category on y-axis ("Furniture", ...)



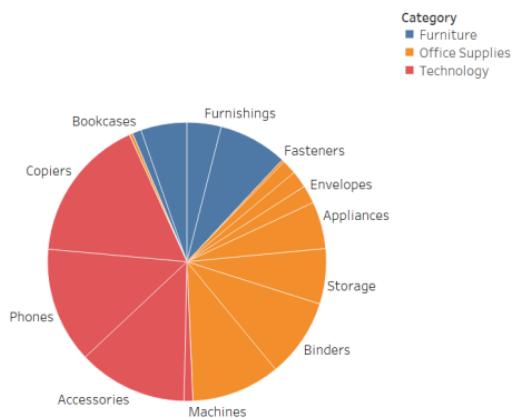
Circular and Polar utilisation

Symbol used:

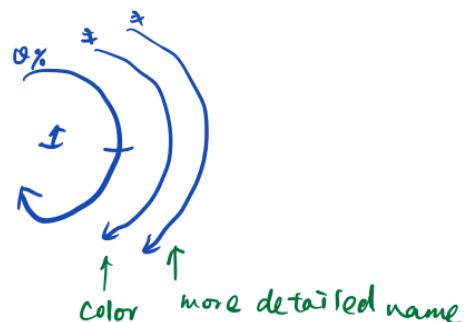


Example 5

Visualisation:



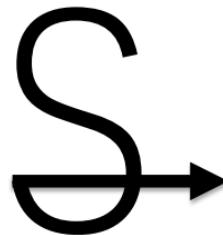
Representation:



Arrangement, Tree (Network)

Axes are not linear nor circular

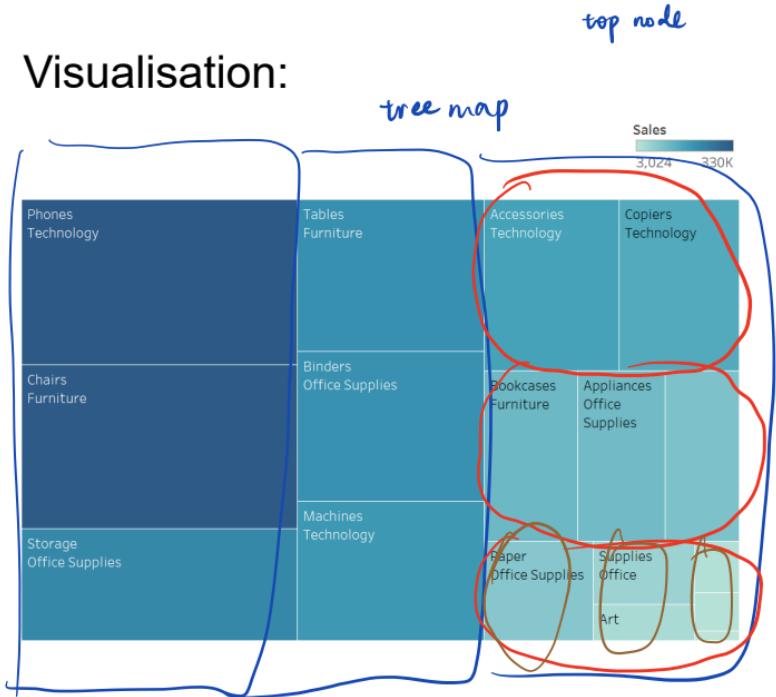
Symbol used:



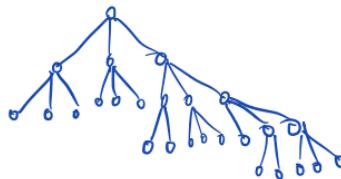
When dimension is also
observed to be in horizontal
order

Example 6

Visualisation:



Representation:

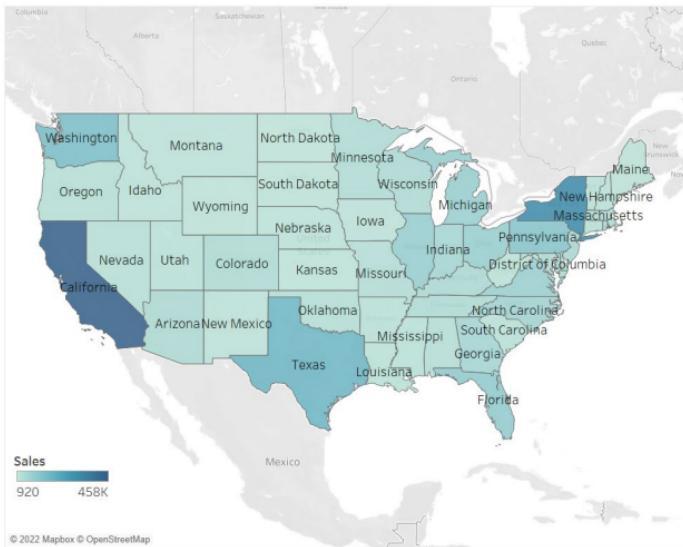


$S^{\uparrow\downarrow}$

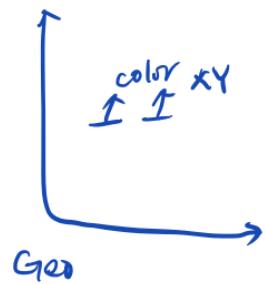
tree : \Rightarrow
 \uparrow : color

Example 7

Visualisation:



Representation:



XY: string name.

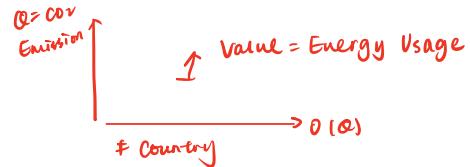
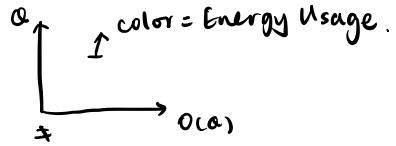
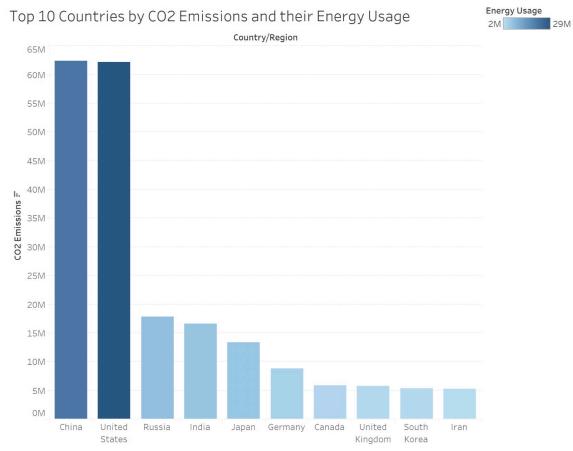
Summary

- What are components of a graphic?
 - The plane
 - Retinal Variables
 - Impositions
- How to create visual representations?
 - By considering level of organisation of components and impositions

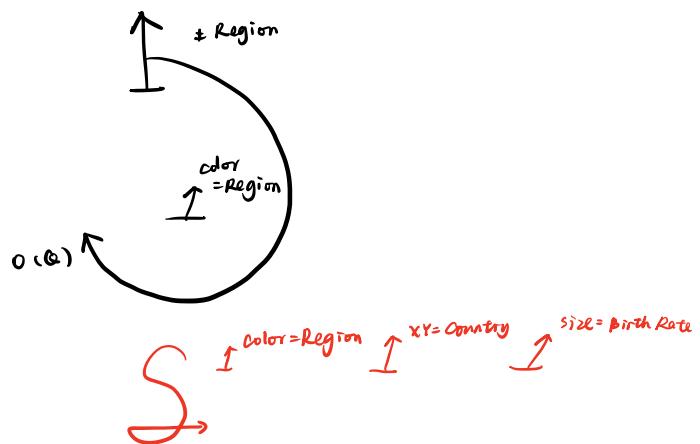
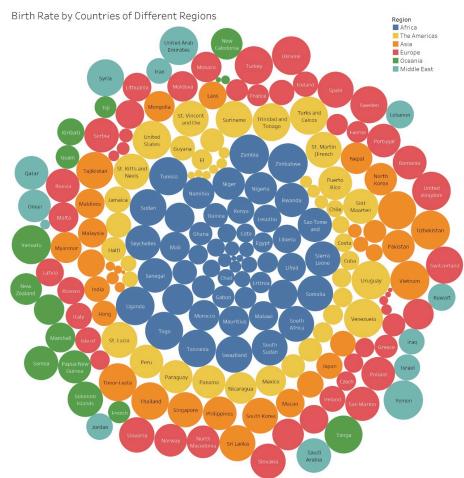


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Question 1



Question 2



Question 3

