# Visual Representation from Semiology of Graphics by J. Bertin

Slides by: Sheelagh Carpendale

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# From a communication perspective

**"**Communication is too often taken for granted when it should be taken to pieces**."** (Fiske'91)

**Two basic schools of thought**

**1. Process**

- the common sense approach
- concerned with the transmission of messages
- senders and receivers encode and decode
- message is transmitted through some media (TV, voice, hair style, etc.)
- to communicate is to effect another's state of mind or behaviour
- effect should as intended, no intention -> no communication
- involves examination of transmission and explanations of failure
- sender responsible/ receiver viewed as quite passive

# From a communication perspective

**“**Communication is too often taken for granted when it should be taken to pieces**.”** (Fiske’91)

**Two basic schools of thought**

**2. Semiotics**

- a study of signs and the cultures that use them
- a **sign** is defined as **anything that stands for something other than itself**
- an exchange of meaning
- recognition that people understand a given set of signs differently
- alternate interpretations rather than failures
- a message is made up of signs, signs are then interpreted
- interpreter/receiver/user rises in importance
- reading becomes active, discovering meaning, putting signs together in terms of ones background and culture
- different readings possible, in fact probable.

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# Creating a visualization

1. Understand a system of related information and tasks.

2. Create a mapping from the data (digital representation) to a visual representation.

3. Present this visual representation on the computer screen.

4. Provide methods of interacting with this visual representation that can include methods for varying the presentation and methods for varying the representation.

5. Verify the usefulness of the representation, the way it is presented and/or and its interaction methods.

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# What is meant by representation?

- Fuzzy general usage, common mis-definition - "*A* represents *B* to the extent that *A* resembles *B*"
  - does one twin represent their sibling?
  - does one item of the assembly line represent another?
  - does a painting of Churchill represent him?

- Solving a problem simply means representing it so as to make the solution transparent … ***(Simon, 1981)***
- Useful representations
  - allow people to *find* relevant information
    - information may not be present
    - information may be present but hard to find
  - allow people to *compute* desired conclusions
    - computations may be difficult or "for free" depending on representations

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# Creating Visual Representations

- A practical look at how to create the visual mapping that is capable of communicating

- to communicate with words we first need to know phonemes, the letters and how they combine to create words
  - note that phonemes and letters are meaningless in themselves

- are there corresponding visual units?
  - there is still considerable debate on this subject

- in the meantime, we will look at a practical approach of how we can create visual representations that can be understood.

  Jacques Bertin

# Bertin's disclaimer

- **Bertin considers**
  - printable, on white paper,
  - visible at a glance
  - reading distance of book or atlas
  - normal and constant lighting
  - readily available graphic means

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# Where does one start?

- with marks!
  - for us, pixels
- Visual Variables: how can we vary marks?
  - by where we place them
  - by how we place them (Bertin calls this ‘implantation’)
  - by their visual characteristics (Bertin calls these retinal variables)

# The Plane

- Points
  - “A point represents a location on the plane that has no theoretical length or area. This signification is independent of the size and character of the mark which renders it visible.”
  - a location
  - marks that indicate points can vary in all visual variables
- Lines
  - “A line signifies a phenomenon on the plane which has measurable length but no area. This signification is independent of the width and characteristics of the mark which renders it visible.”
  - a boundary, a route, a connection
- Areas
  - “An area signifies something on the plane that has measurable size. This signification applies to the entire area covered by the visible mark.”
  - an area can change in position but not in size, shape or orientation without making the area itself have a different meaning

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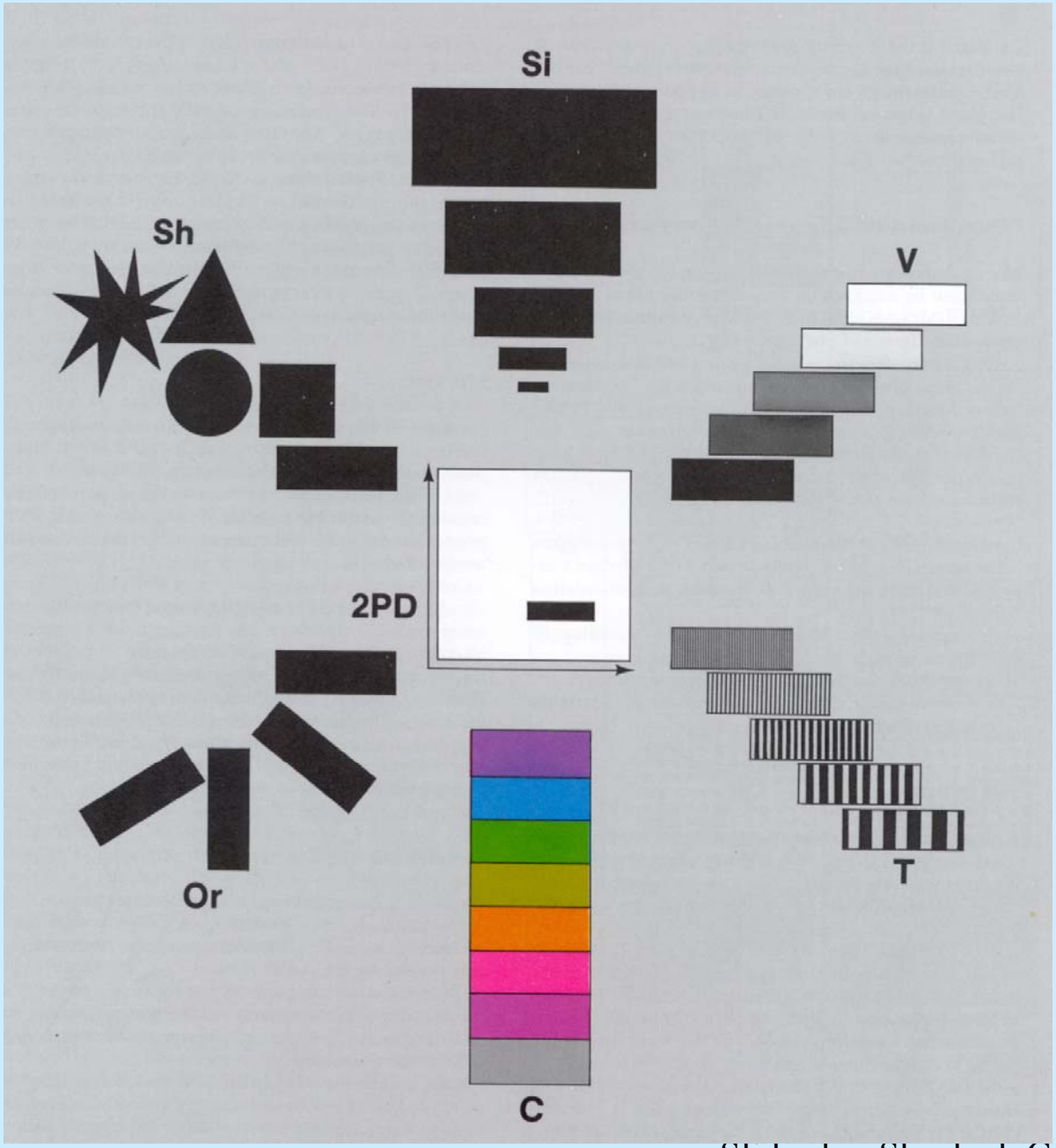
# Visual Variables

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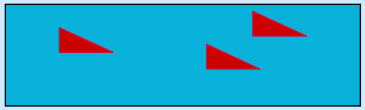
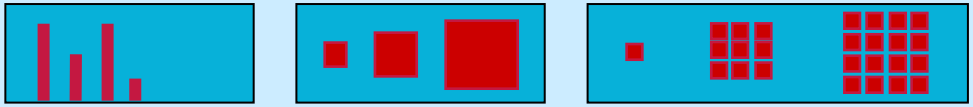
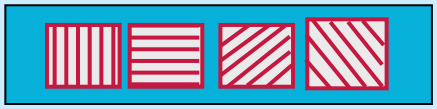
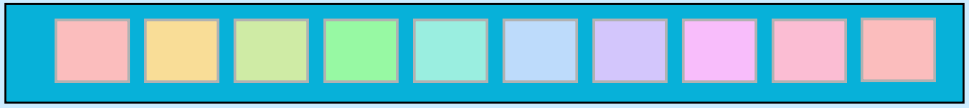
# Visual Variables

- **position**
  - changes in the x, y, (z) location
- **size**
  - change in length, area or repetition
- **shape**
  - infinite number of shapes
- **value**
  - changes from light to dark
- **orientation**
  - changes in alignment
- **colour**
  - changes in hue at a given value
- **texture**
  - variation in pattern
- **motion**









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# Visual Variables on a computer?

- **motion**
  - direction, acceleration, speed, frequency, onset, ‘personality
- **saturation**
  - colour as Bertin uses it largely refers to hue, other readily available colour channels (i.e. saturation)
- **flicker**
  - frequency, rhythm, appearance
- **depth?** ‘quasi’ 3D
  - depth, occlusion, aerial perspective, binocular disparity
- **illumination**
- **transparency**

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# Visual Variables

**Characteristics of visual variables can be**

- **selective**

  is a change in this variable enough to allow us to select it from a group?

- **associative**

  is a change in this variable enough to allow us to perceive them as a group?

- **quantitative**

  is there a numerical reading obtainable from changes in this variable?

- **order**

  are changes in this variable perceived as ordered?

- **length**

  across how many changes in this variable are distinctions perceptible?

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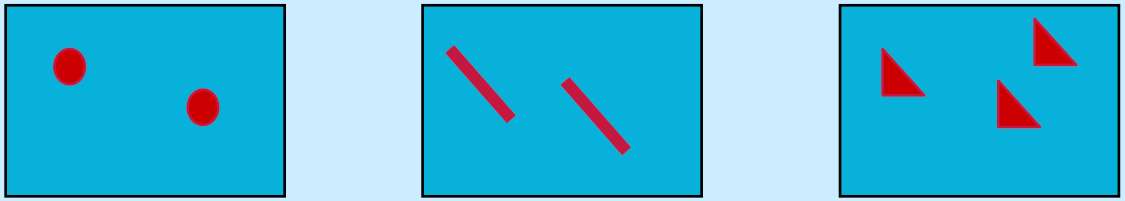
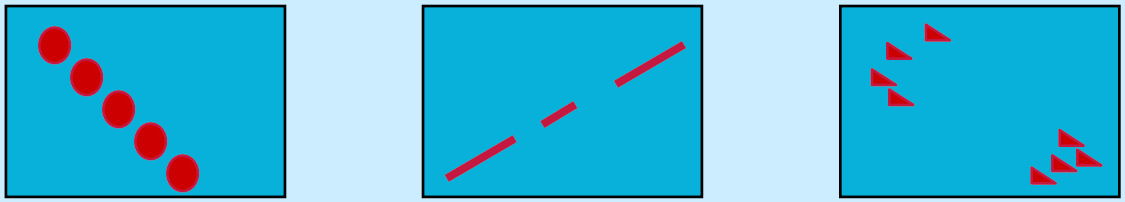
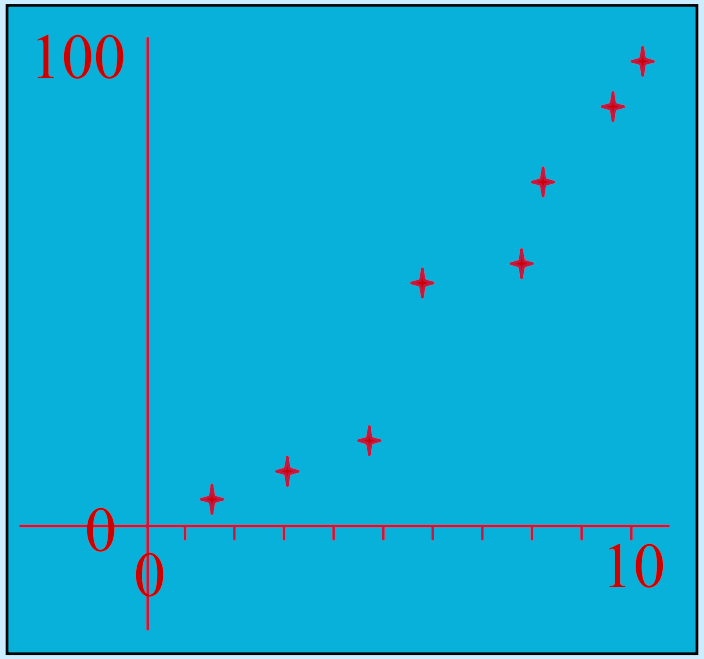
# Visual Variable: Position

- selective
- associative
- quantitative
- order
- length





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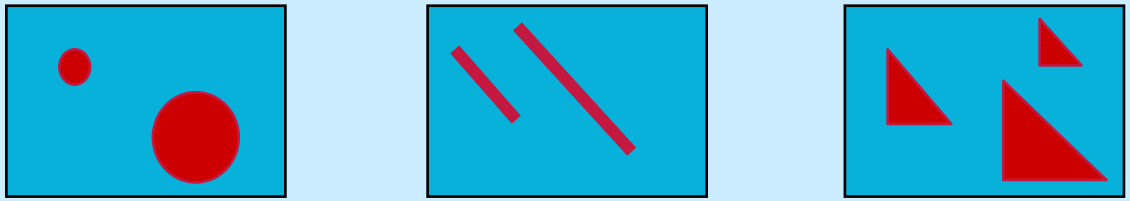
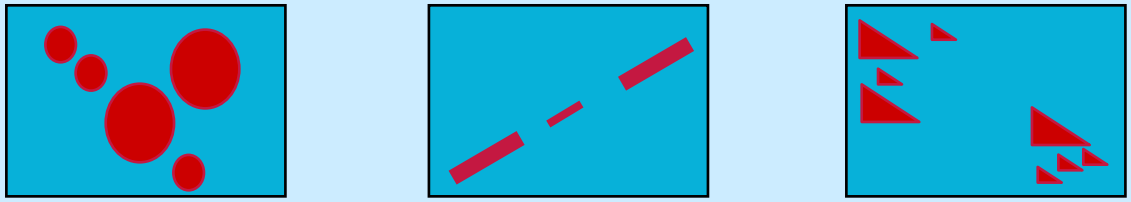
# Visual Variable: Size

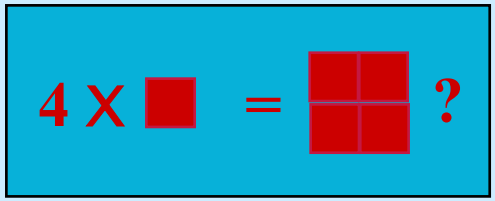
- selective



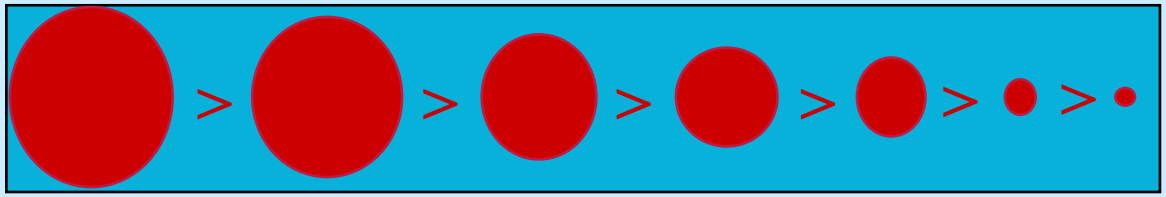
- associative



- quantitative




- order




- length
  - theoretically infinite but practically limited
  - association and selection ~ 5 and distinction ~ 20

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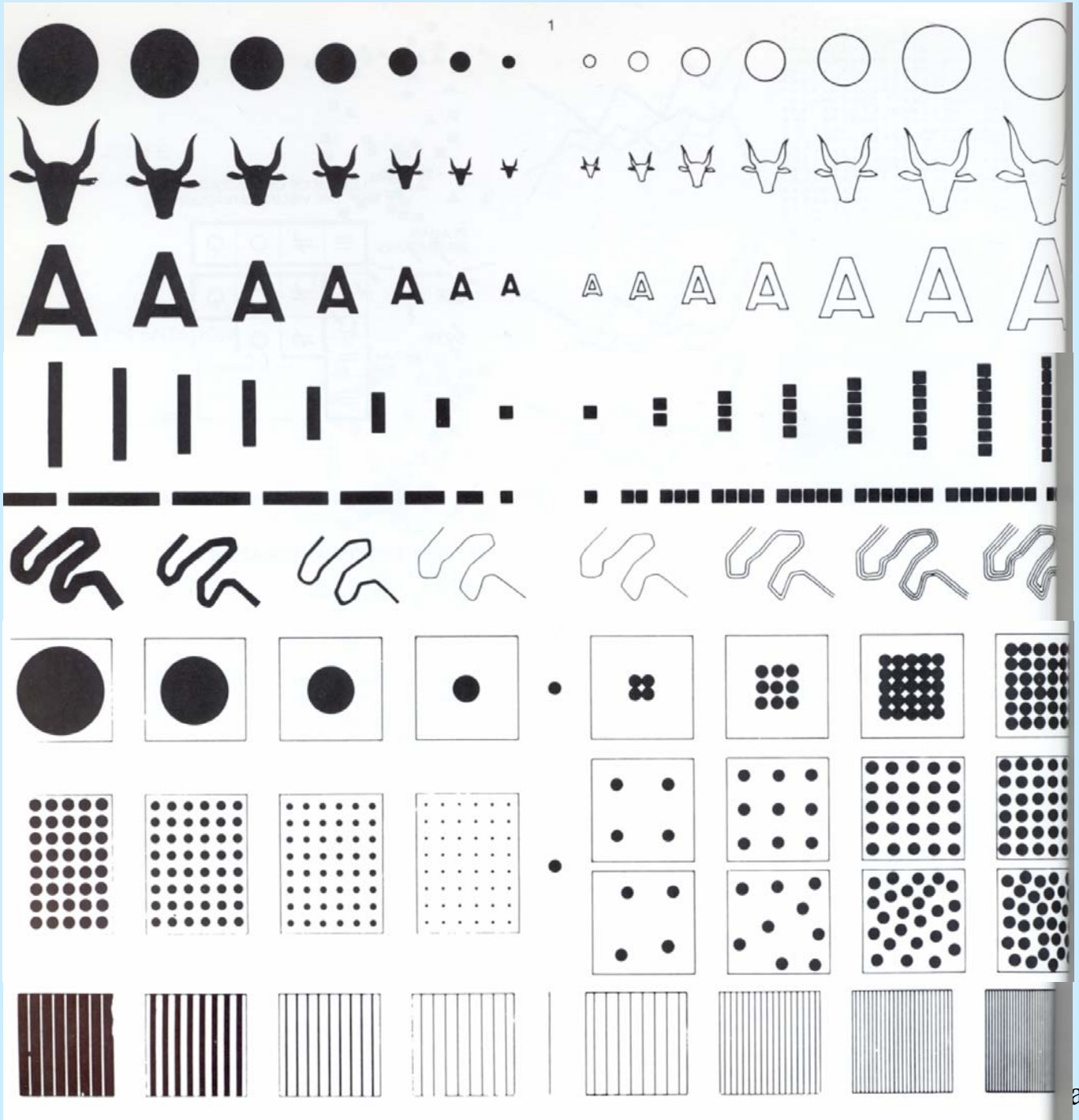
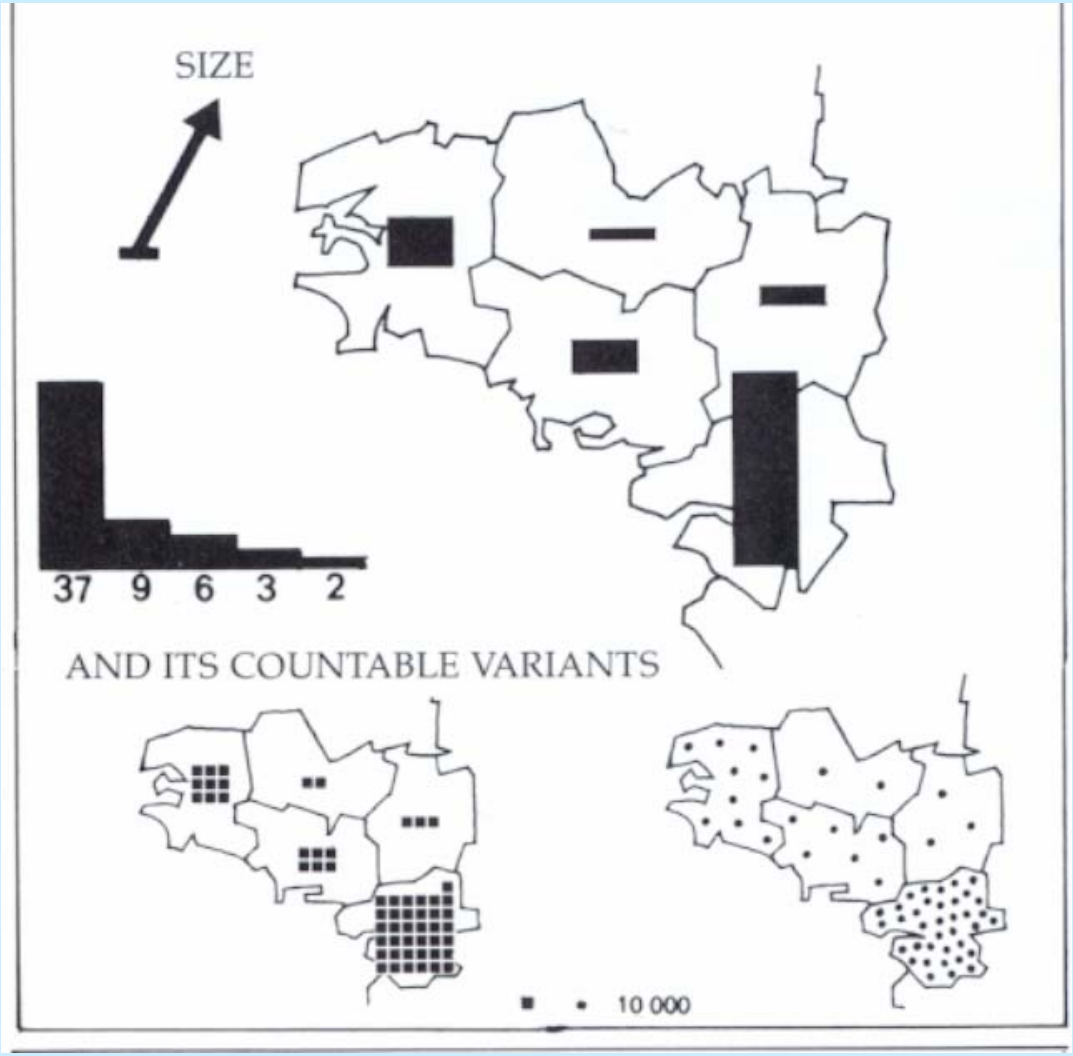
# VV: Size



# Size

- Categories of size,
  - height of a column,
  - area of a sign,
  - number of equal signs

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# Size

points lines areas

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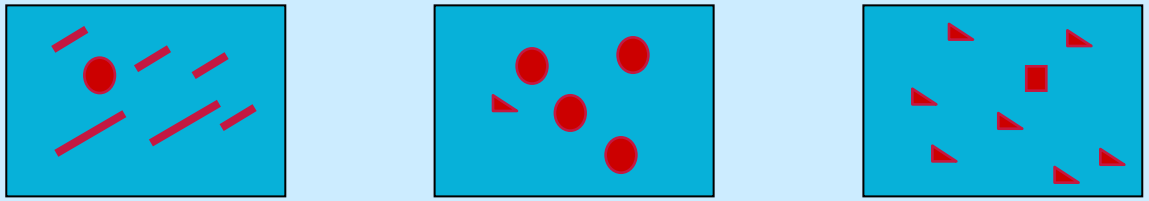
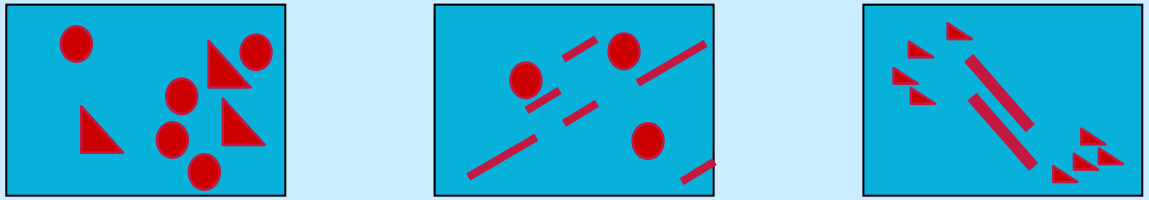
# Visual Variable: Shape

- selective

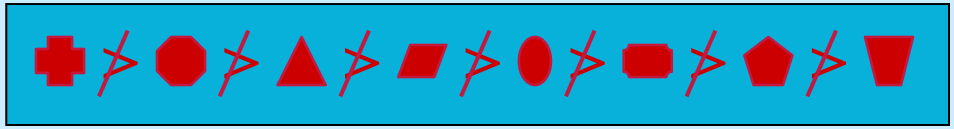


- associative

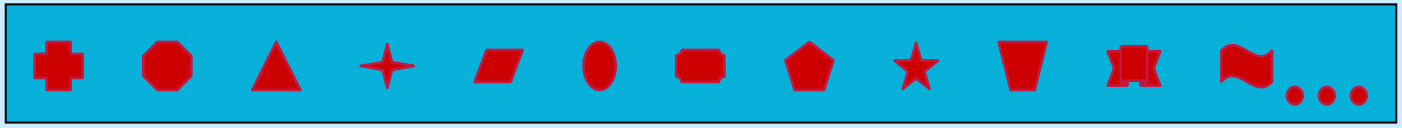


- quantitative

- order



- length
  - infinite



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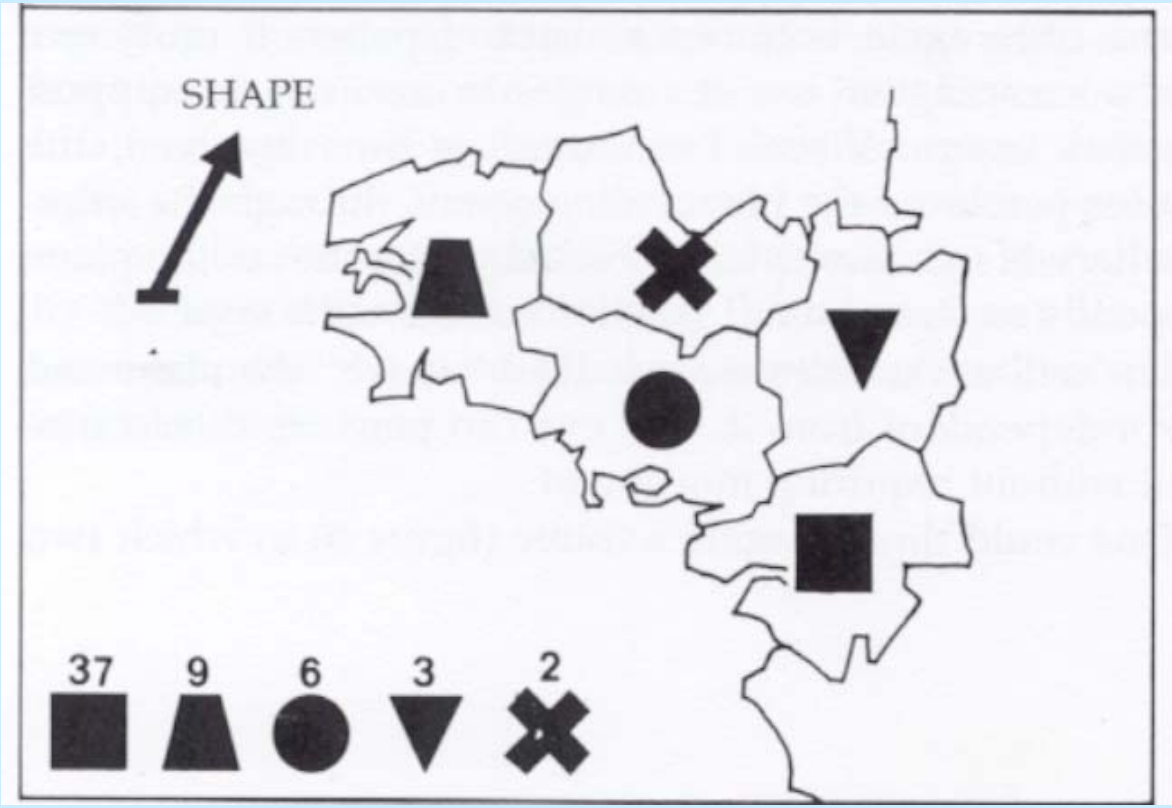
# Shape

- Constant size variation in shape
- Quantity is read through the legend

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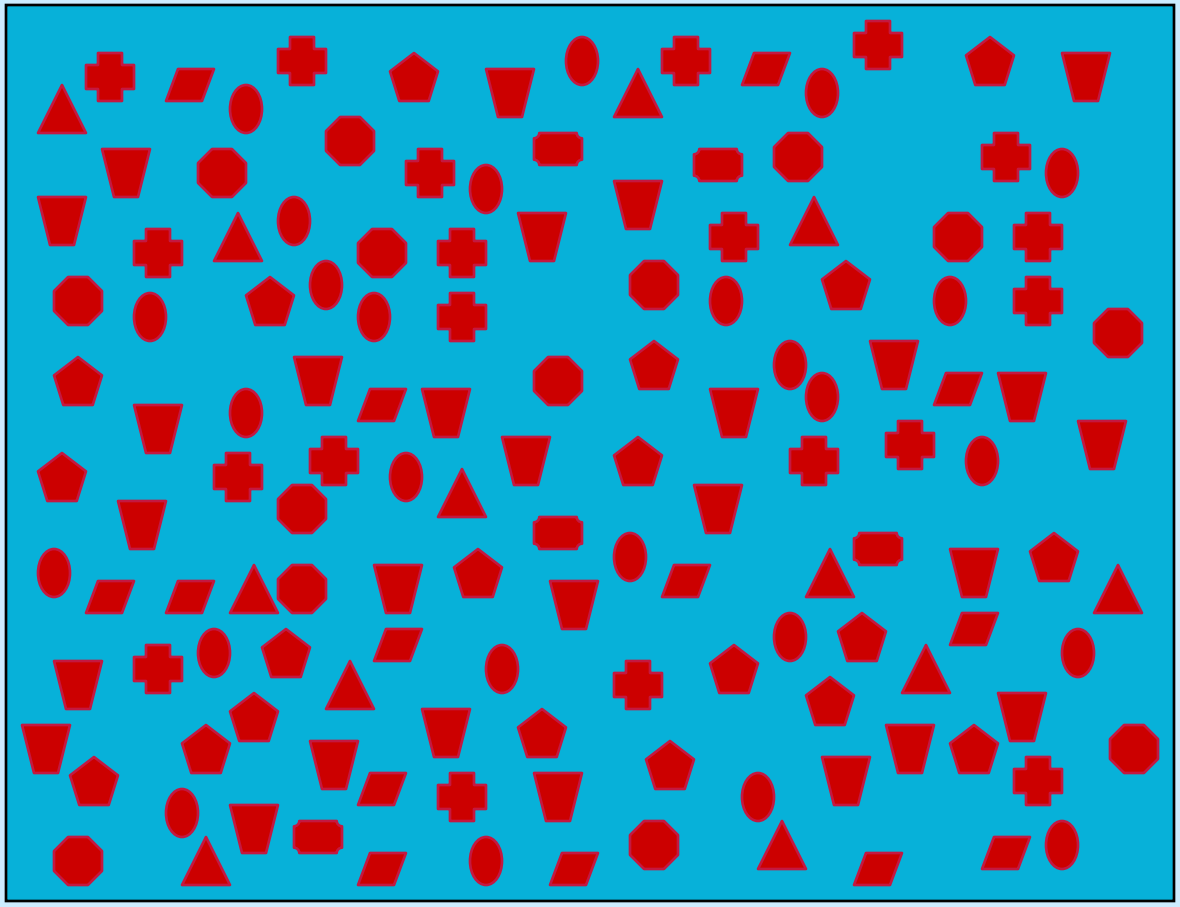
# Shape



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# Shape

points lines areas

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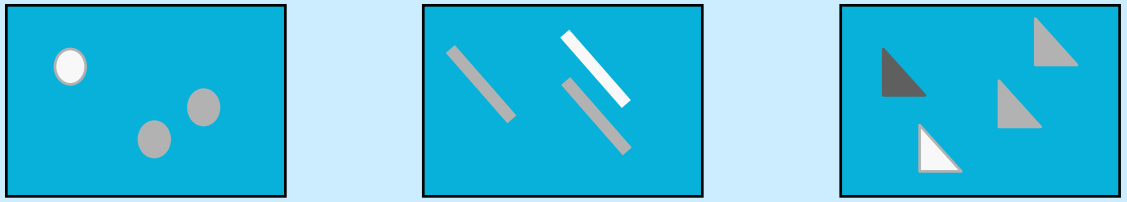
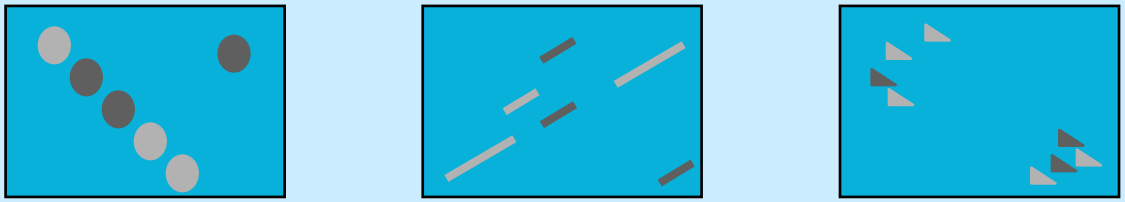
# Visual Variable: Value

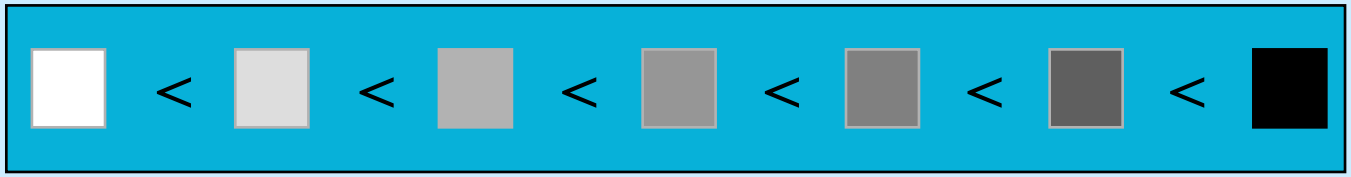
- ✓ selective



- ✓ associative



- ≠ quantitative
- ✓ order




- ✓ length
  - theoretically infinite but practically limited
  - association and selection ~ < 7 and distinction ~ 10

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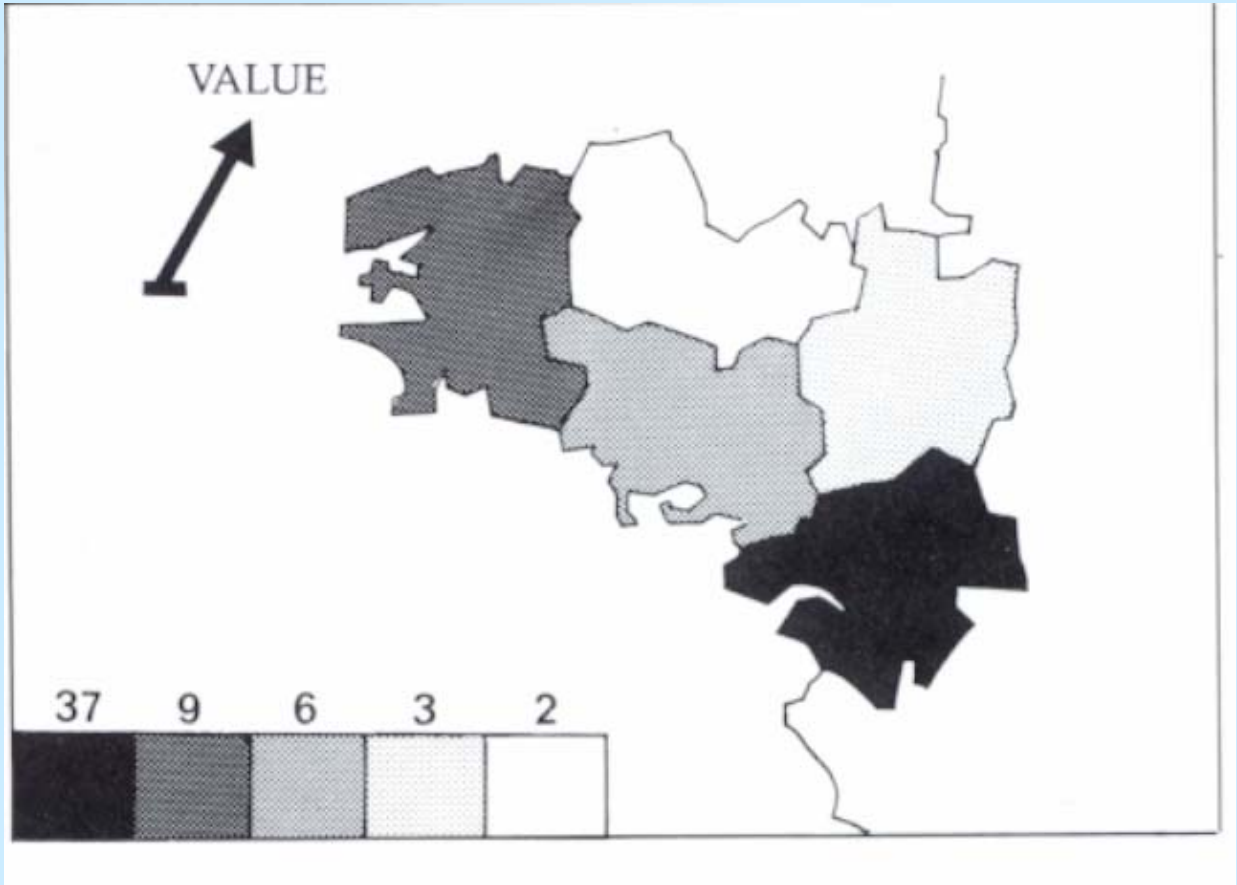
# Value

- Categories of value,
  - various degrees between black and white,

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# Value

points lines areas

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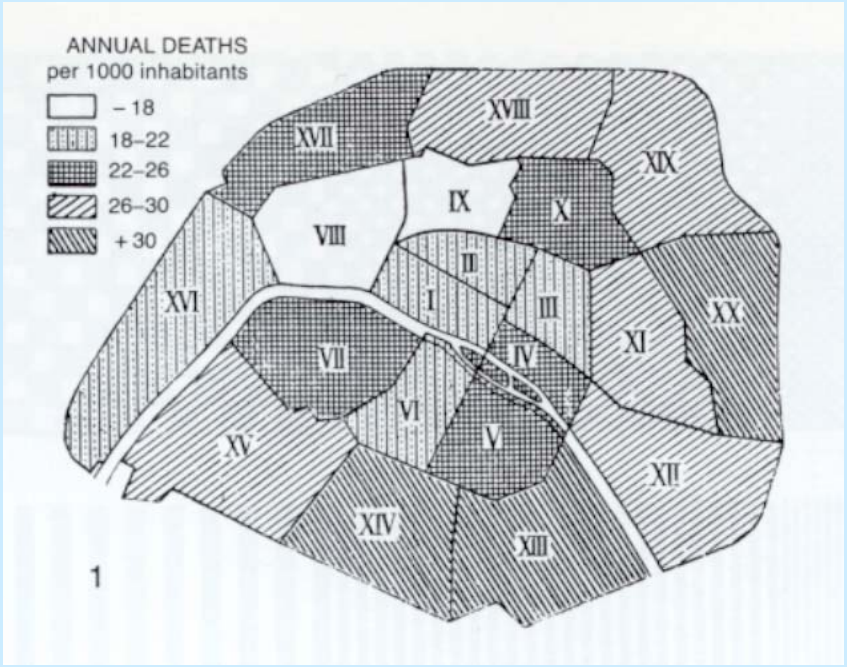
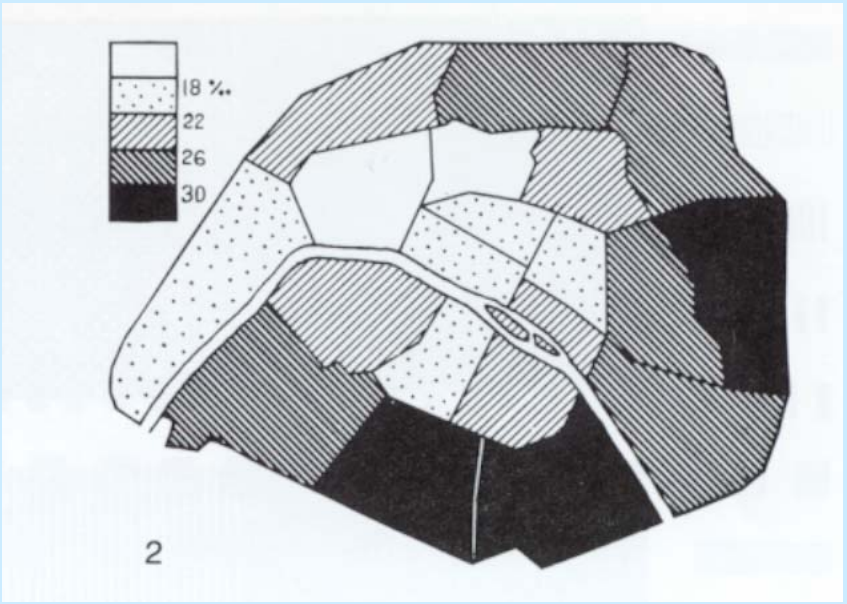
# Visual Variable: Value

- Ordered, and can not be re-ordered

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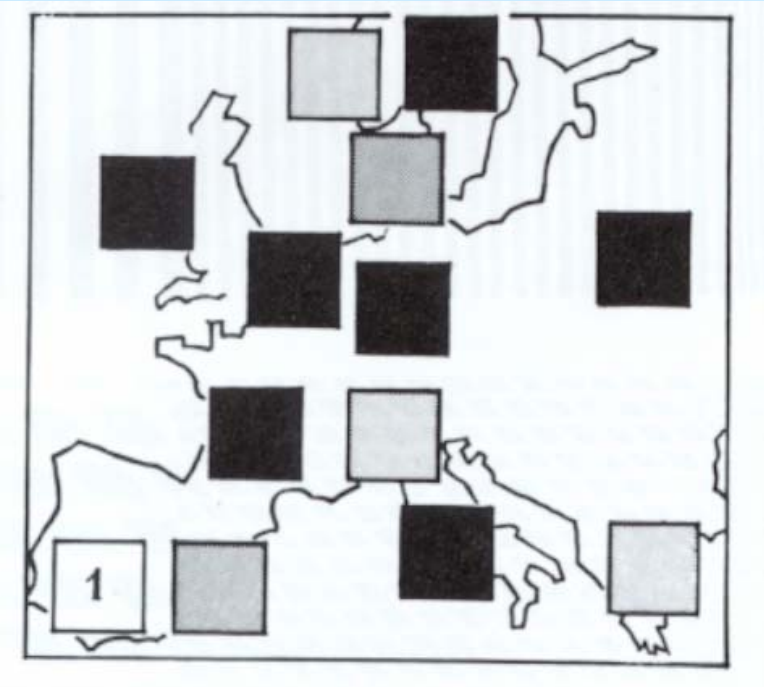
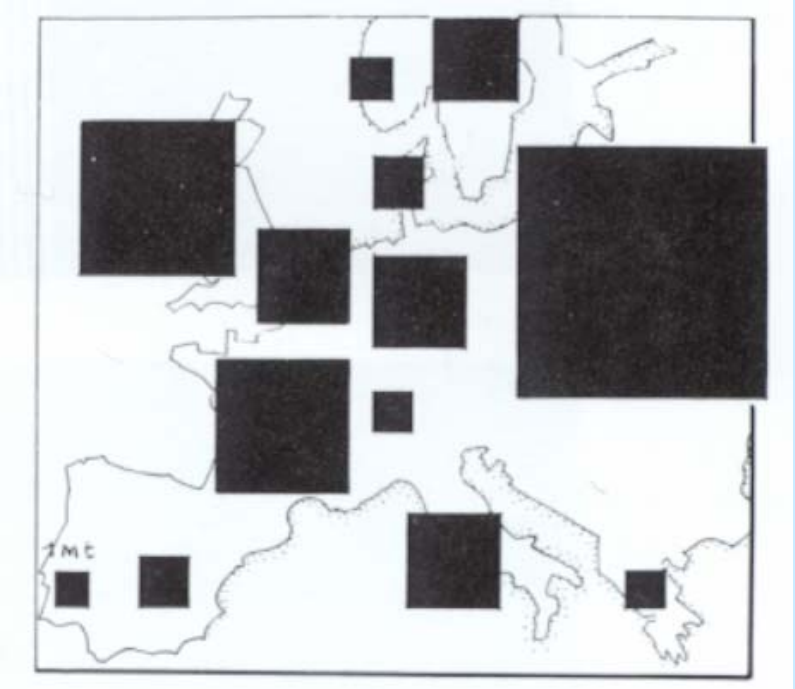
# Visual Variable: Value

- Is not quantitative

  (oil consumption in Europe base unit 1 million tons)

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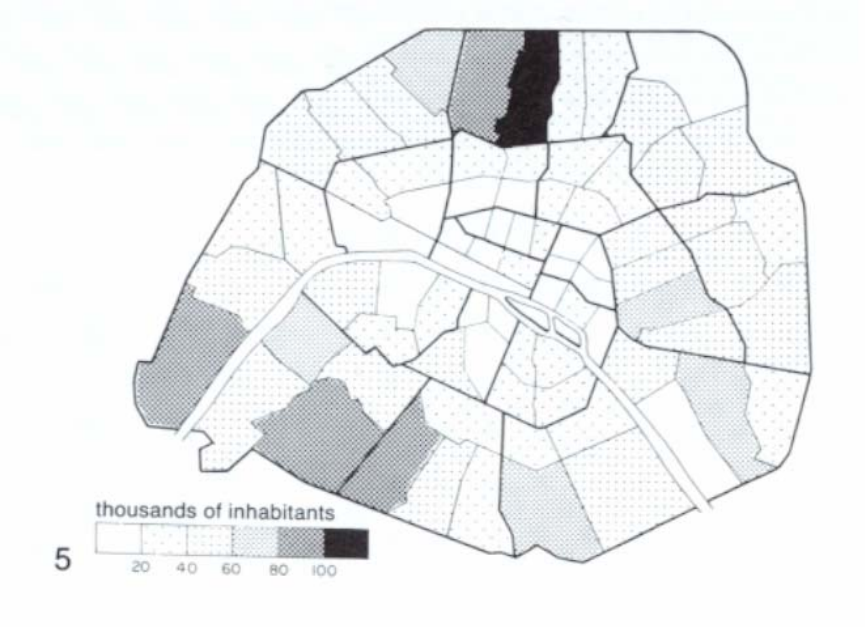
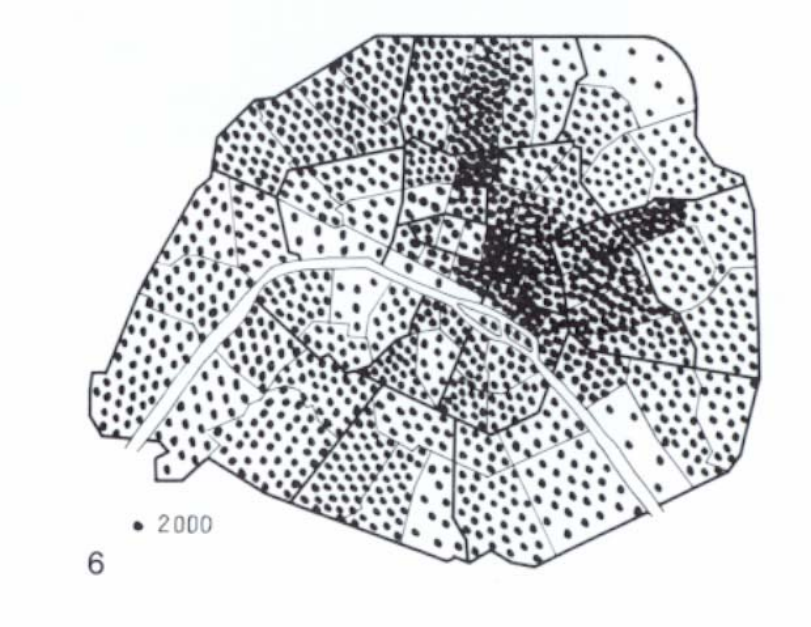
# Visual Variable: Value

- Value intensity can be mis-read as density

  (population of Paris)

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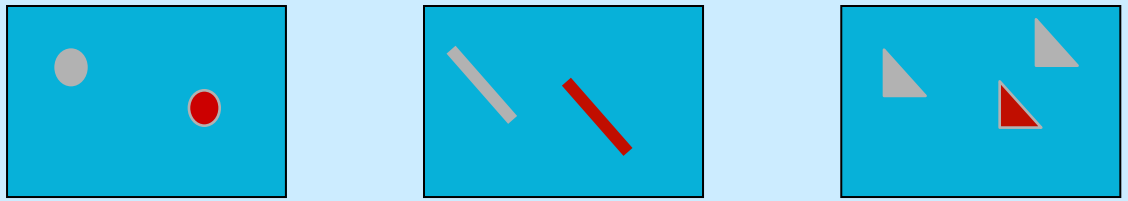
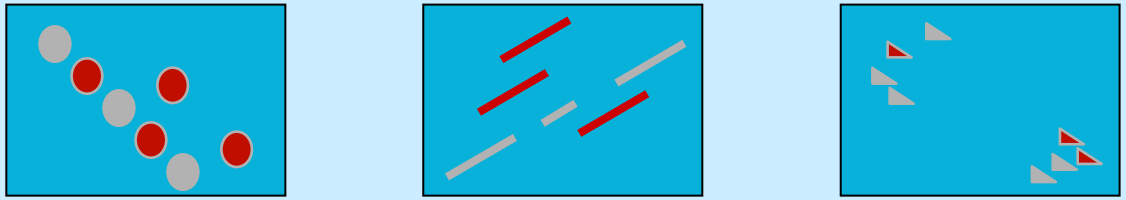
# Visual Variable: Colour

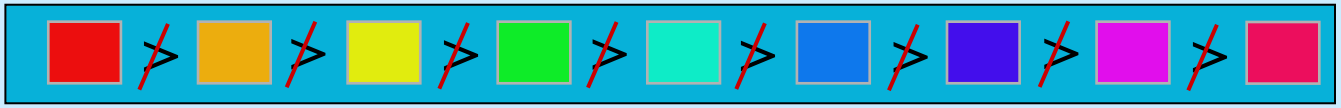
- ✓ selective



- ✓ associative



- ≠ quantitative
- ≠ order



- ✓ length
  - theoretically infinite but practically limited
  - association and selection ~ < 7 and distinction ~ 10

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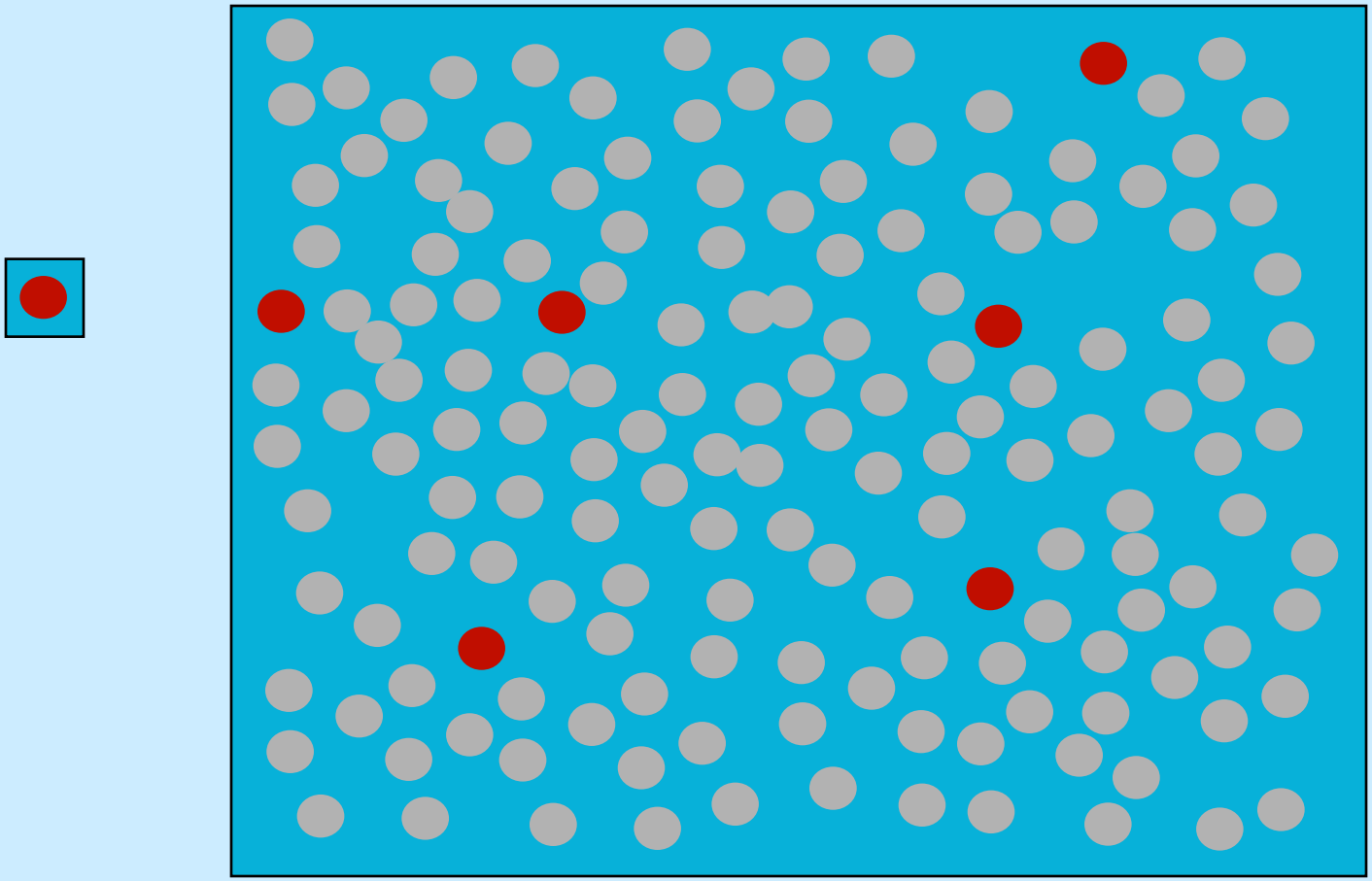
# Colour



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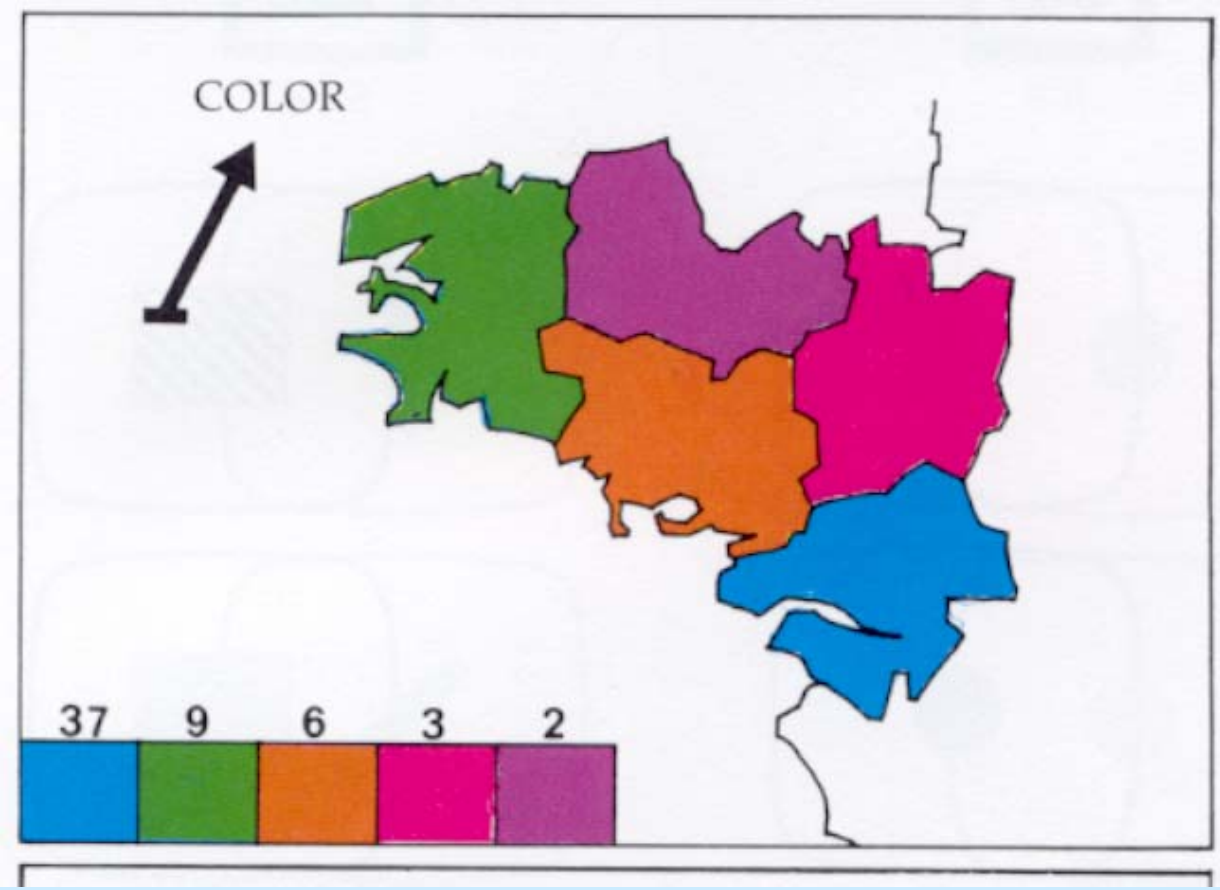
# Colour

- Categories of colour,
  - changes in hue at equal value

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# Colour

points lines areas

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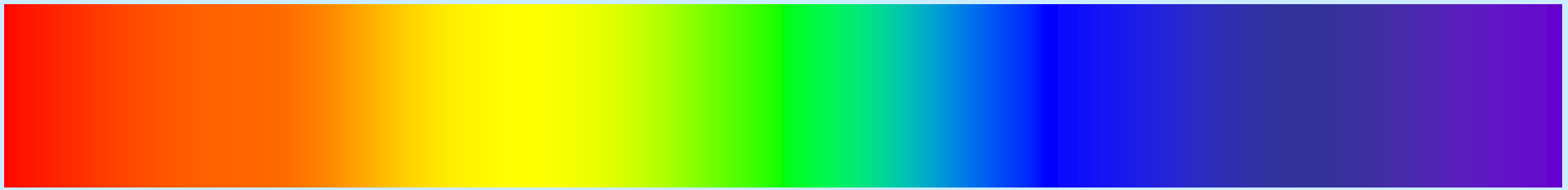
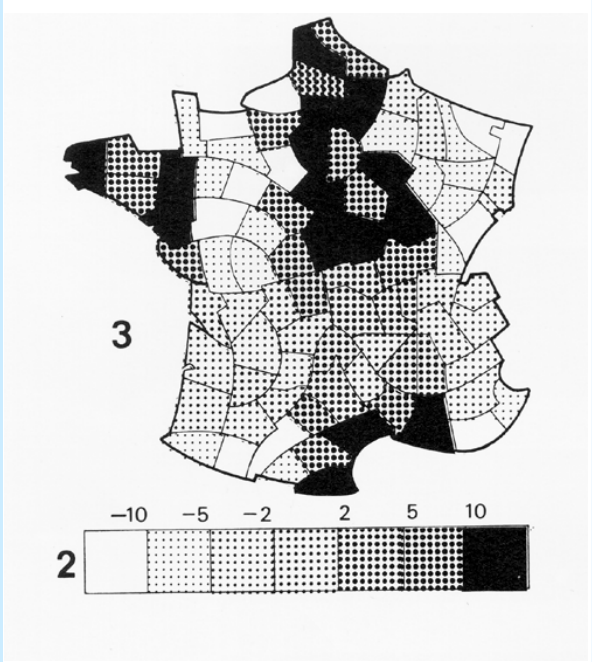
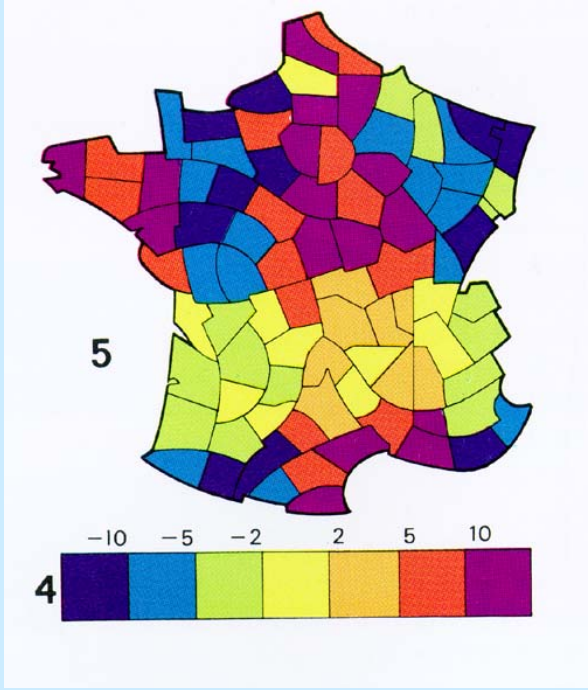
# Encoding

- Common advice says use a rainbow scale
  - Marcus, Murch, Healey
  - problems with rainbows



1


3
2
−10 −5 −2 2 5 10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4
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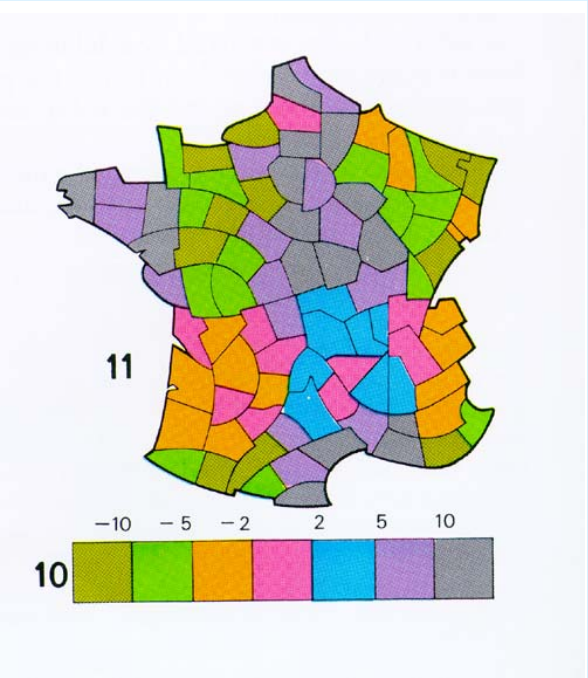
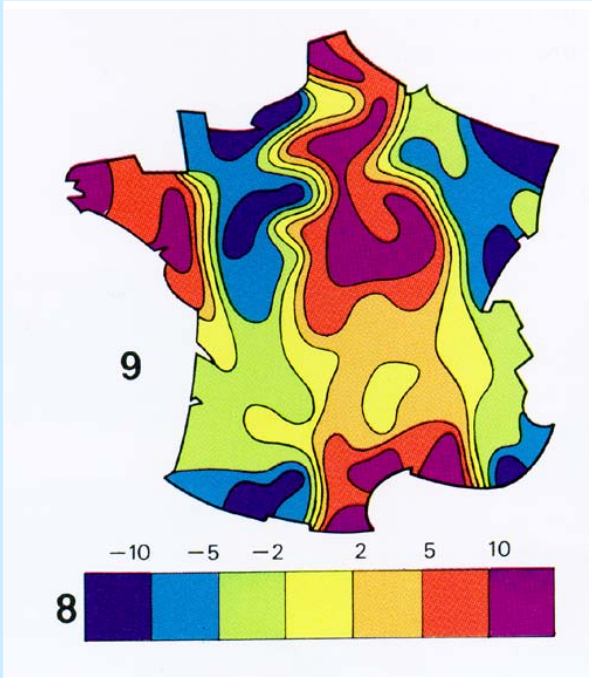
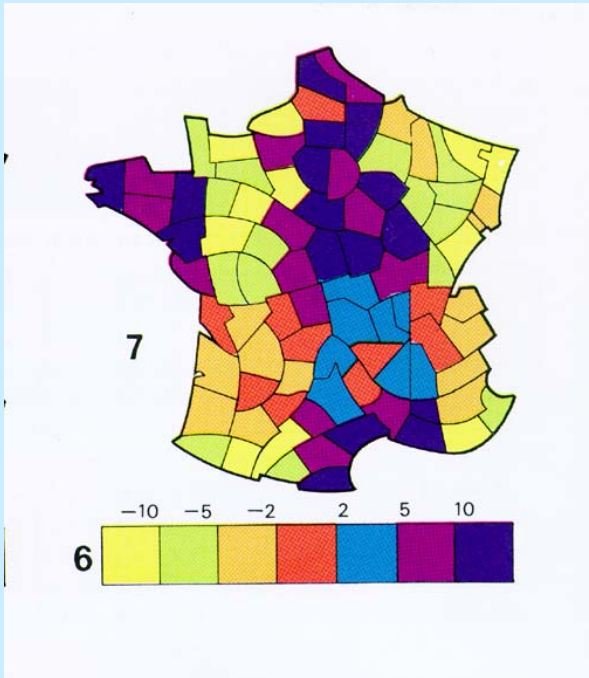
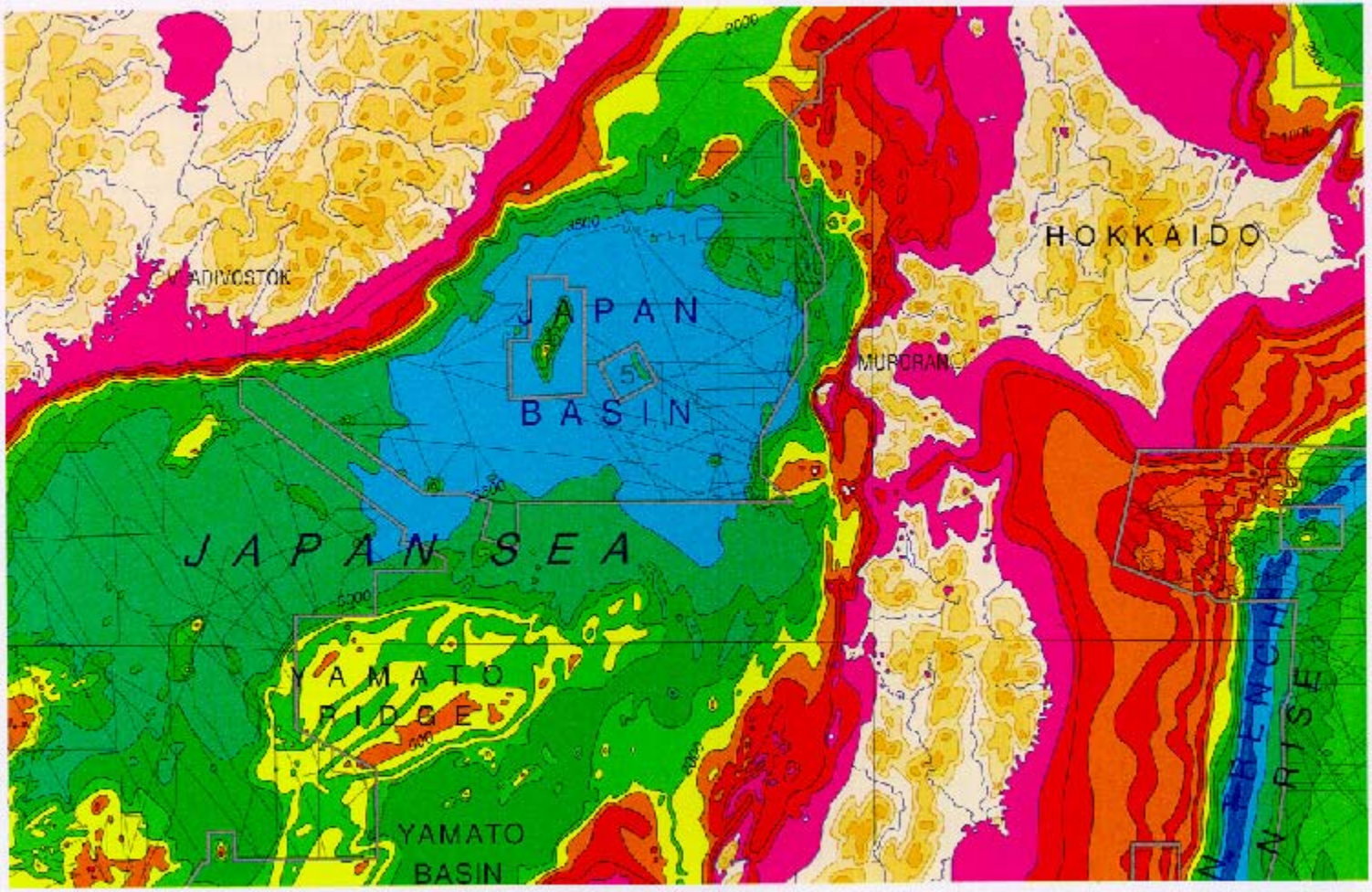
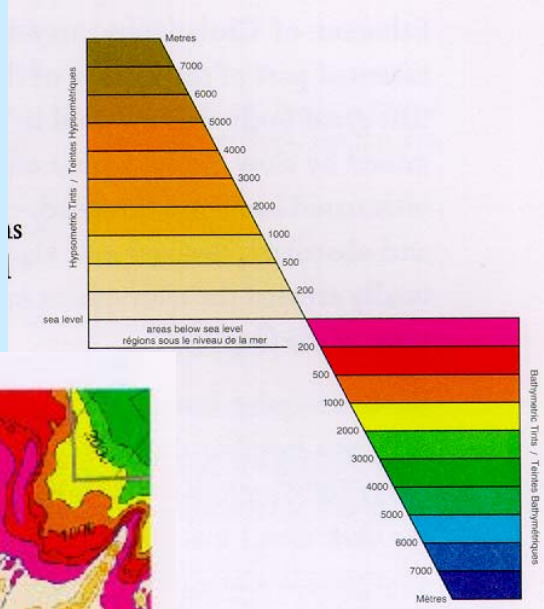

11
10
−10 −5 −2 2 5 10


9
8
−10 −5 −2 2 5 10


7
6
−10 −5 −2 2 5 10

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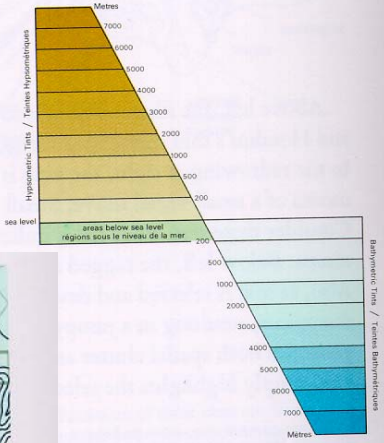
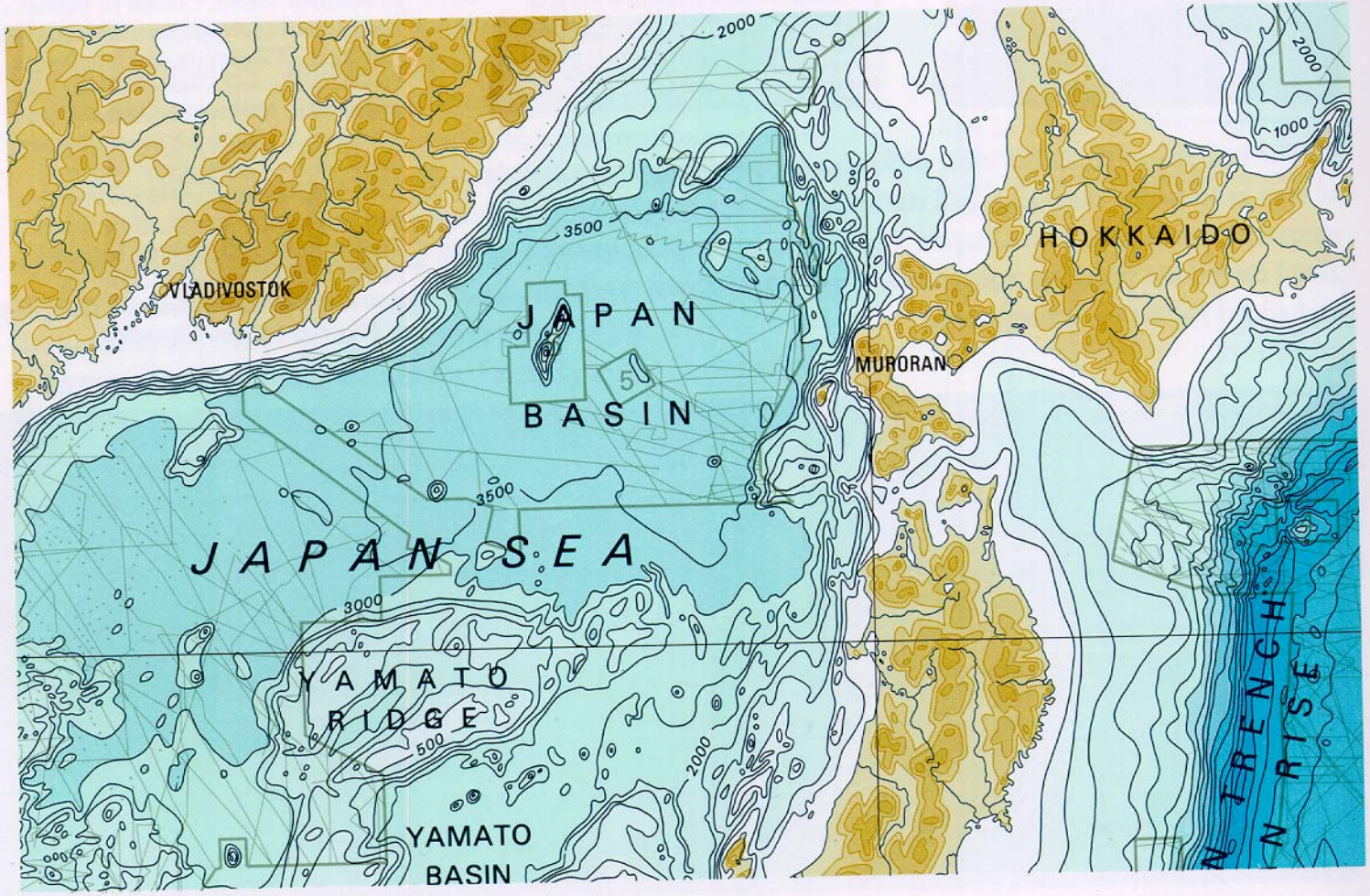
*General Bathymetric Chart of the Oceans*, International Hydrographic Organization (Ottawa, Canada, 5th edition, 1984). 5.06.

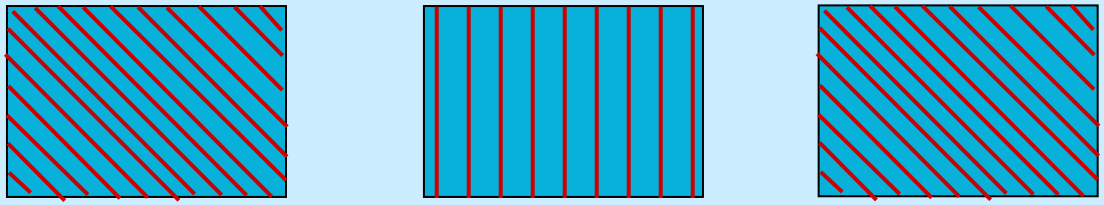


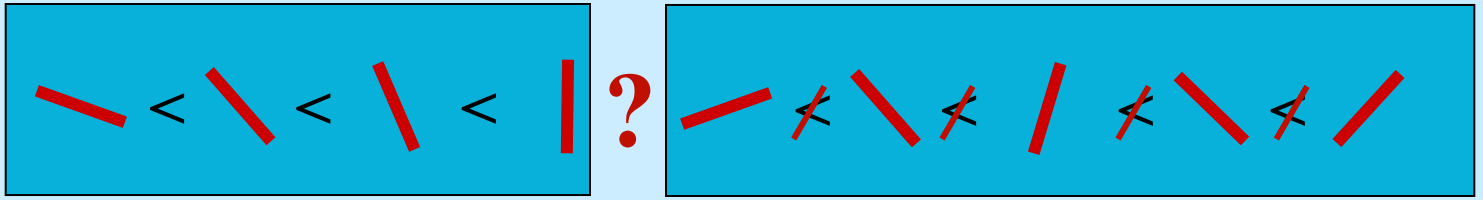
# Visual Variable: Orientation

- ✓ selective

- ✓ associative



- ≠ quantitative
- ≠ order




- ✓ length
  - ~5 in 2D; ? in 3D

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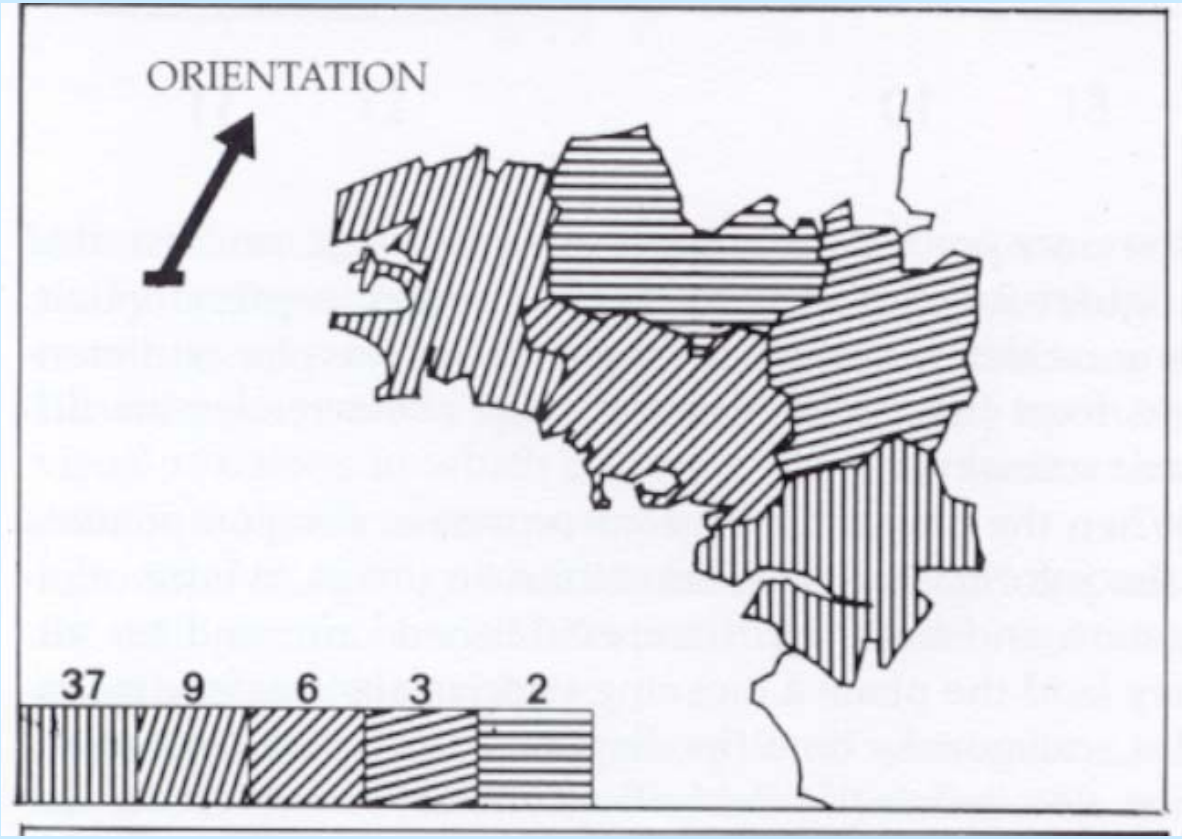
# Orientation

- Categories of orientation,
  - variations is line or line-pattern ranging from the vertical to the horizontal

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# Orientation

points lines areas

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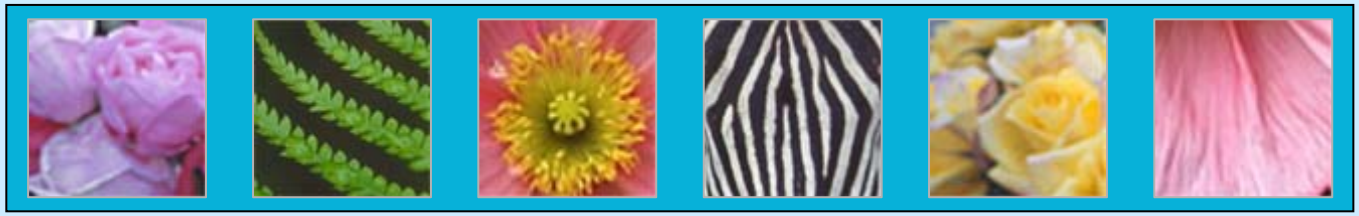
# Visual Variable: Texture

- ✓ selective

- ✓ associative



- ≠ quantitative
- ≠ order

- ✓ length
  - theoretically infinite

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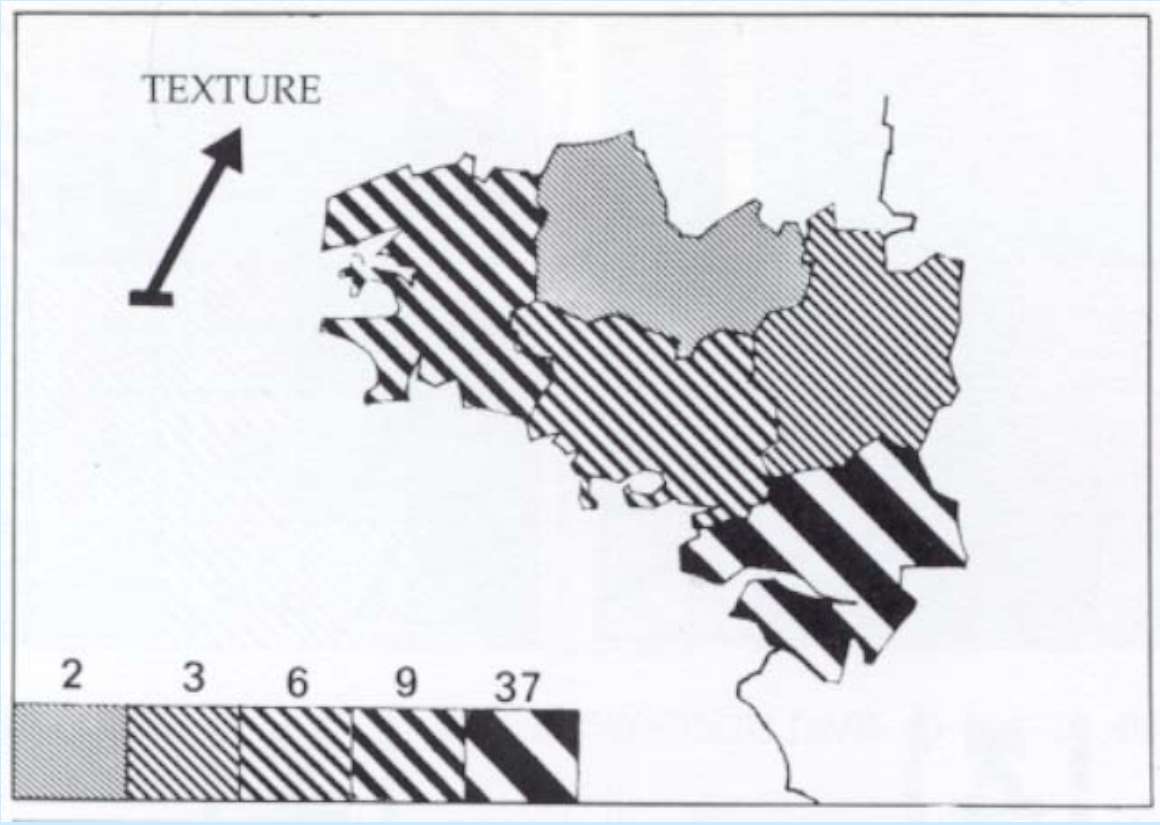
# Texture

- Categories of texture,
  - changes in fineness or coarseness of the marks in an area
  - can be combined changes in characteristics

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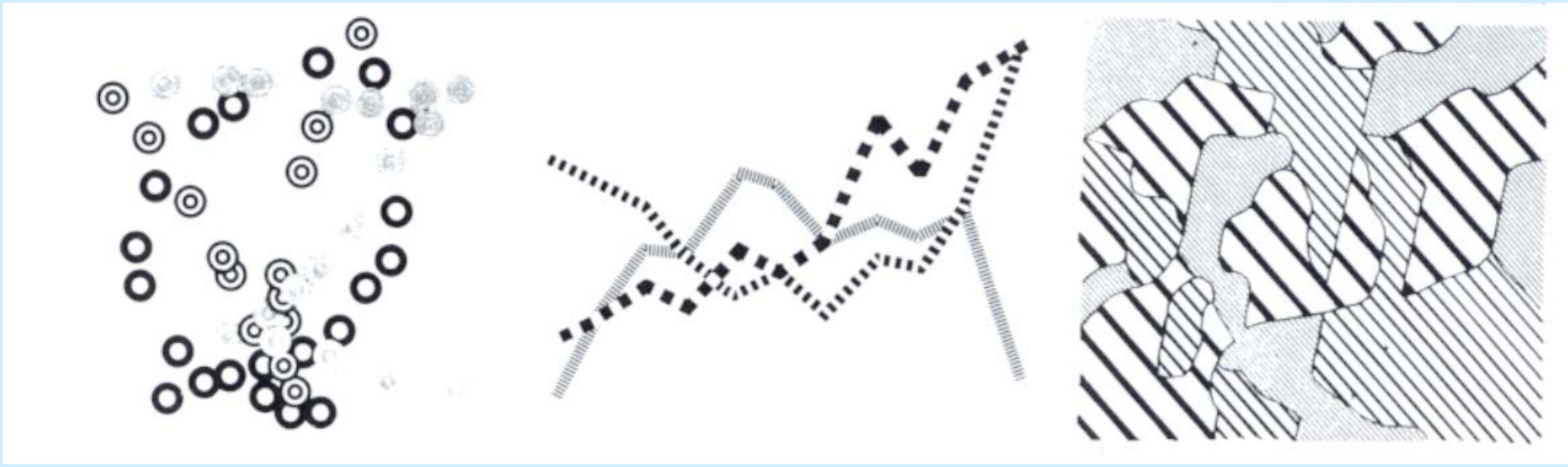
# Texture



points lines areas

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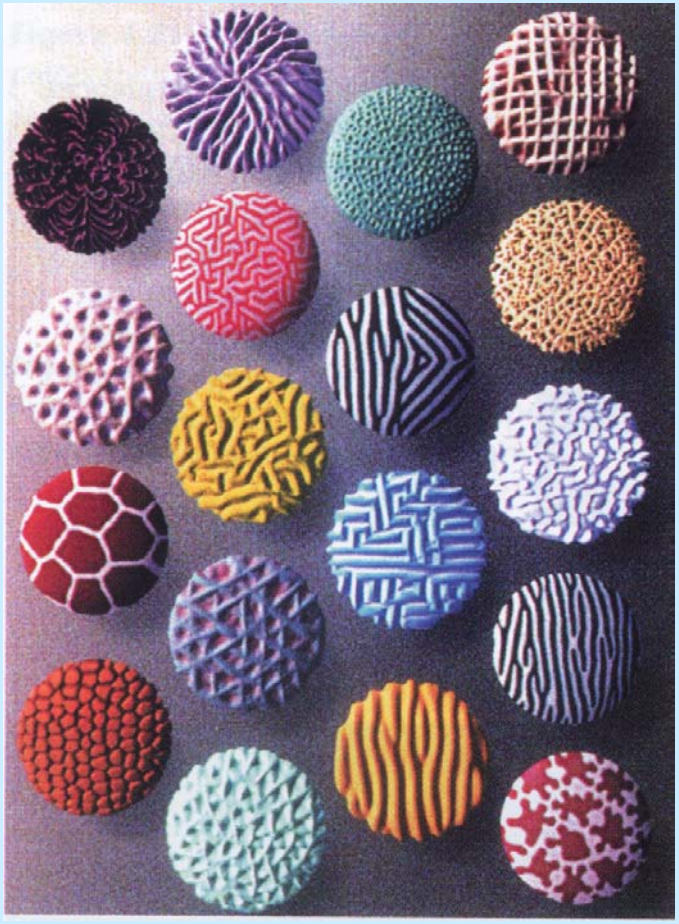
# Textures



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# Visual Variable: Motion

✓ • Selective
  - motion is one of our most powerful attention grabbers

✓ • associative
  - moving in unison groups objects effectively

≠ • quantitative
  - subjective perception

≠ • order

? • length
  - distinguishable types of motion?

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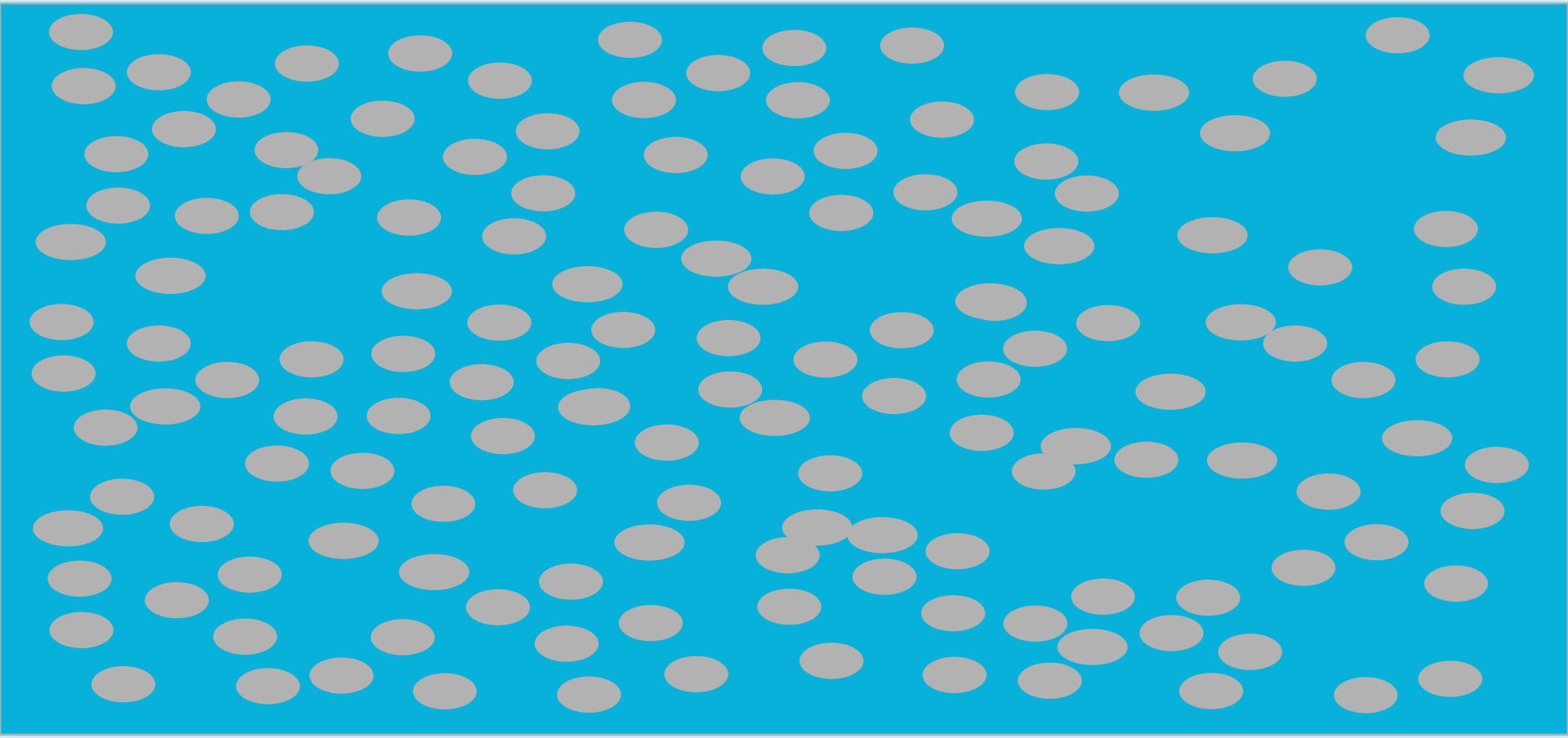
# Motion



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# Information from 4 French communes

| The communes | A | B | C | D | |
|---|---|---|---|---|---|
| Areas | 4 | 4 | 1 | 1 | (10s of $km^2$) |
| Population | 4 | 8 | 2 | 4 | (1000s of persons) |
| Density of pop. | 1 | 2 | 2 | 4 | (%) |

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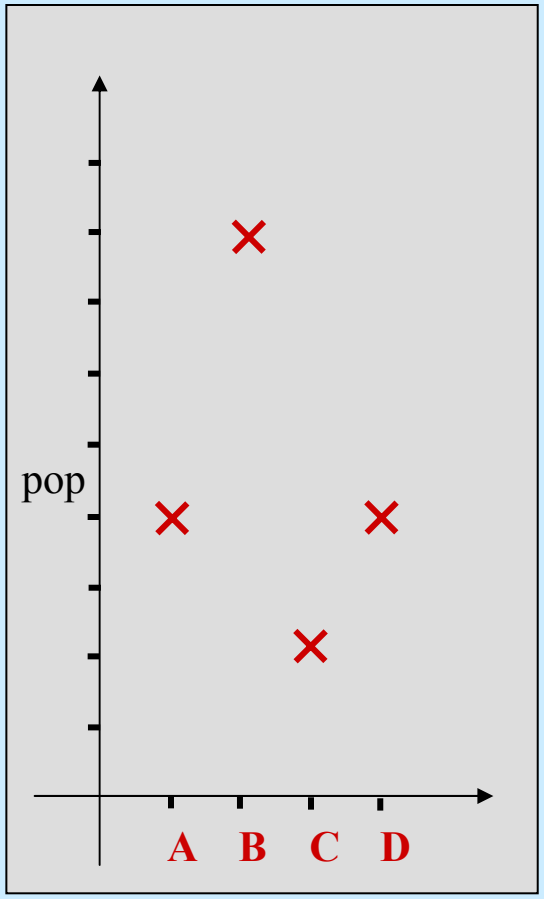
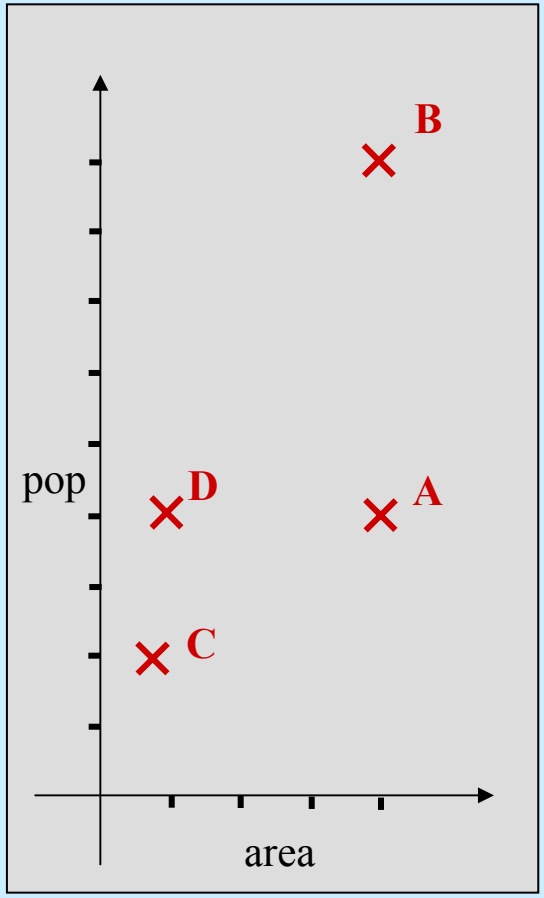
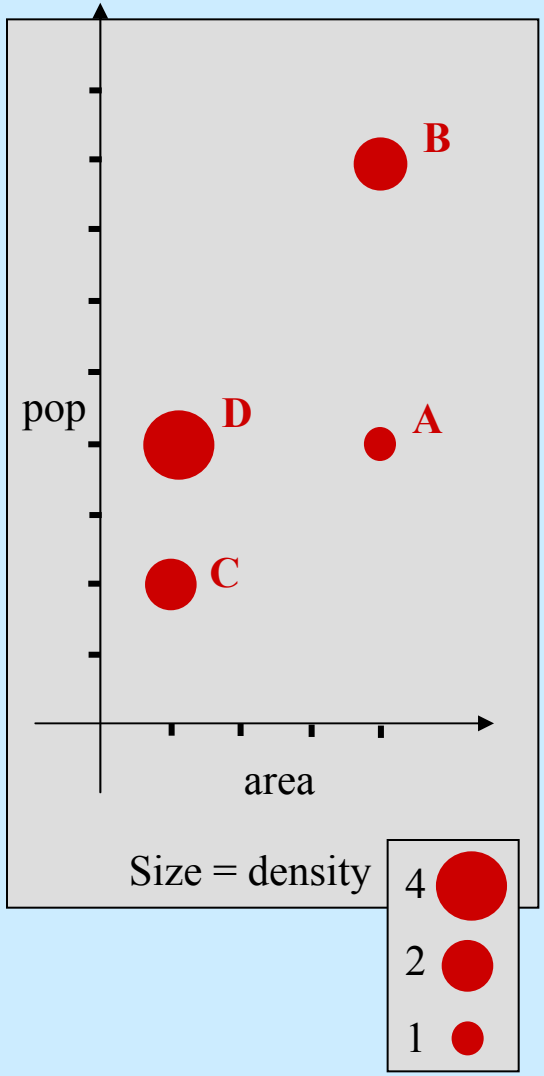
# Point Representations

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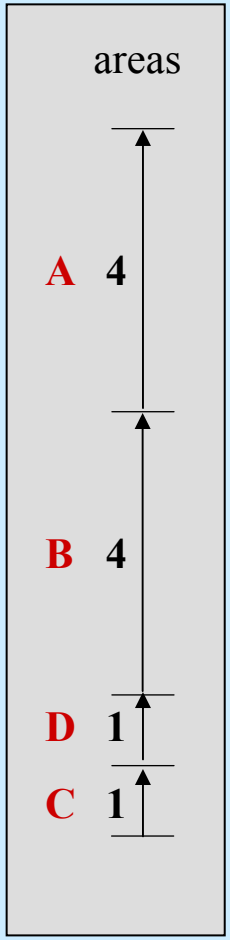
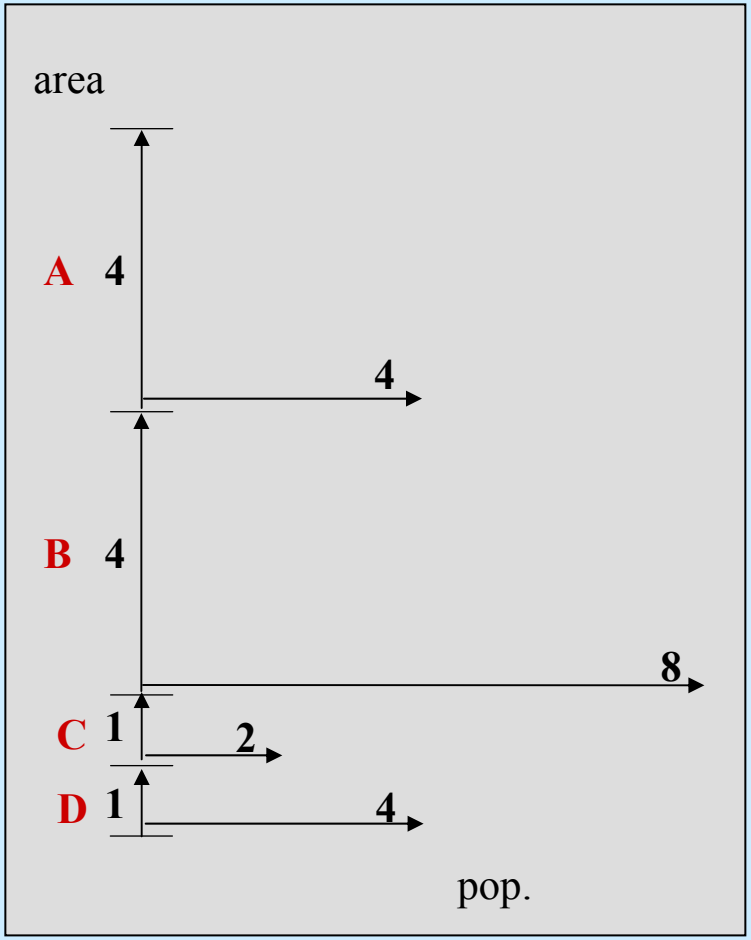
# Line Representations

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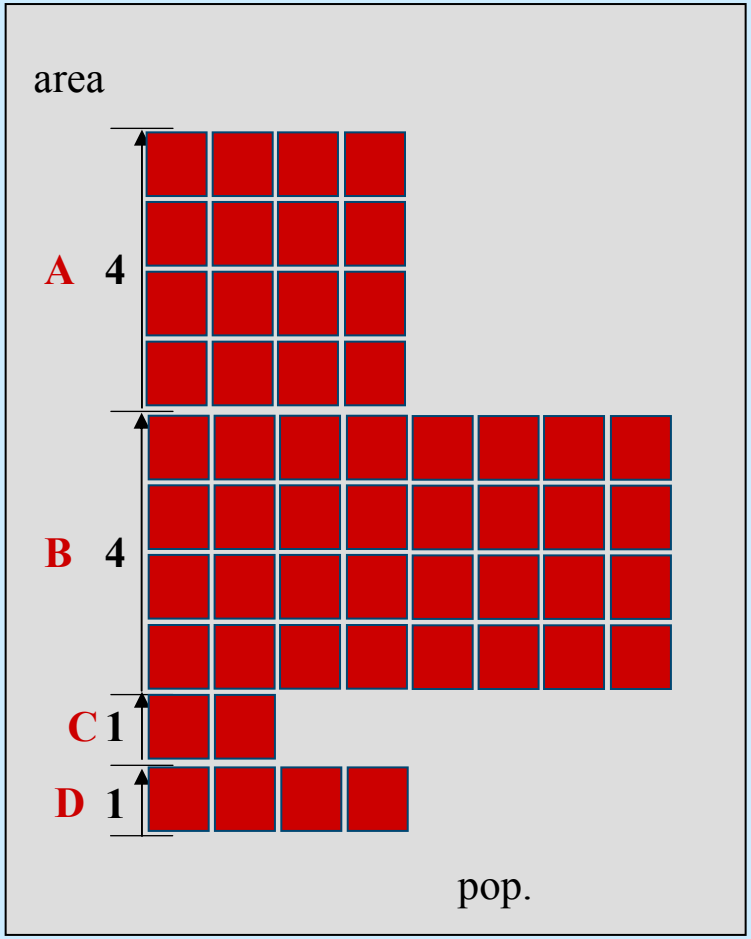
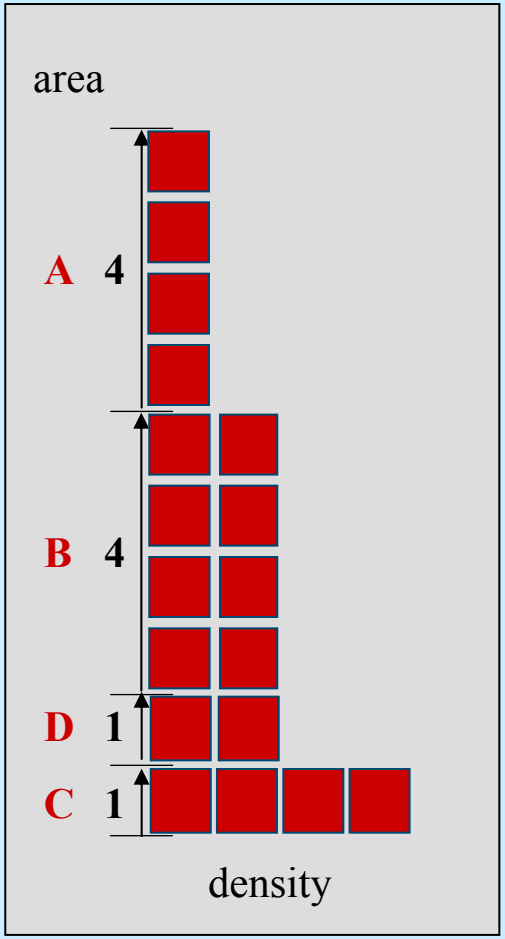
# Line Representations

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# Area Representations

| | |
|---|---|
| C | A |
| D | B |

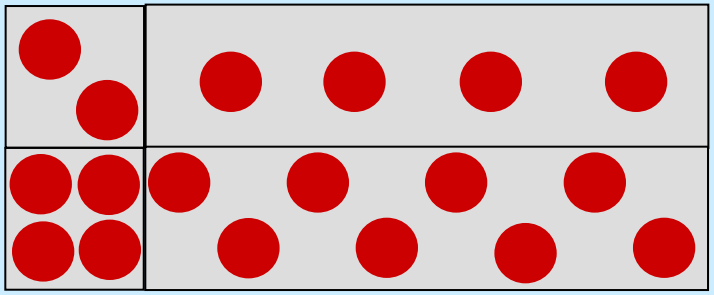
Area proportional to size

population

| | |
|---|---|
| 2 | 4 |
| 4 | 8 |

density of population

| | |
|---|---|
| 2 | 1 |
| 4 | 2 |



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# Area Representations

| | | | | | |
|---|---|---|---|---|---|
| C | C | A | A | A | A |
| C | C | | | | |
| D | D | B | B | B | B |
| D | D | | | | |

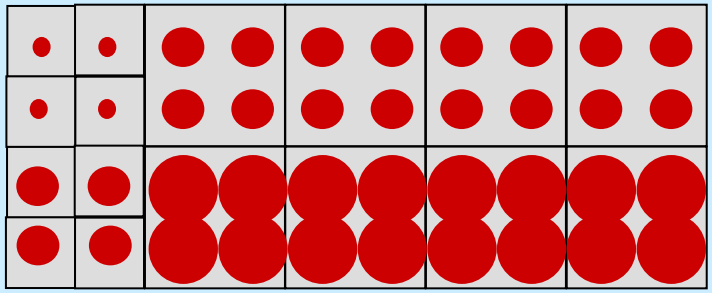
Area proportional to size

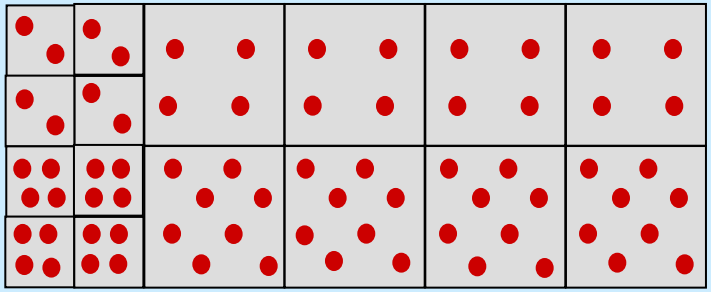
population

| | | | | | |
|---|---|---|---|---|---|
| 2 | 2 | 4 | 4 | 4 | 4 |
| 2 | 2 | | | | |
| 4 | 4 | 8 | 8 | 8 | 8 |
| 4 | 4 | | | | |

density of population

| | | | | | |
|---|---|---|---|---|---|
| 2 | 2 | 1 | 1 | 1 | 1 |
| 2 | 2 | | | | |
| 4 | 4 | 2 | 2 | 2 | 2 |
| 4 | 4 | | | | |





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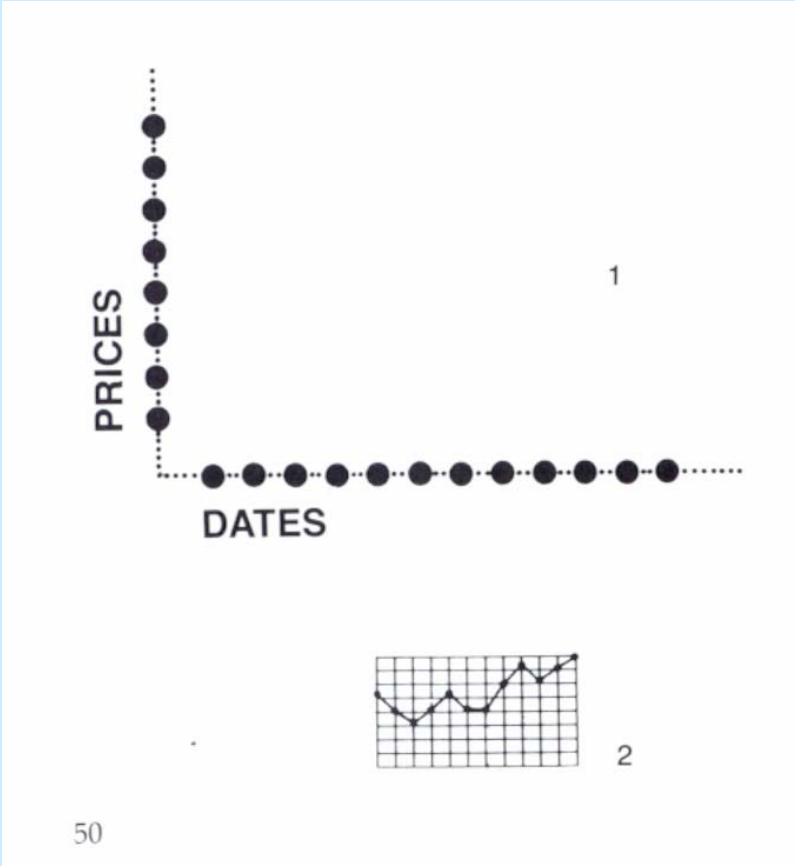
# First group: Diagrams

- When correspondences can be established between
  - all the divisions of one component and
  - all the divisions of another

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# Second group: Networks

- When correspondences can be established among
  - all the divisions of the same component

steps

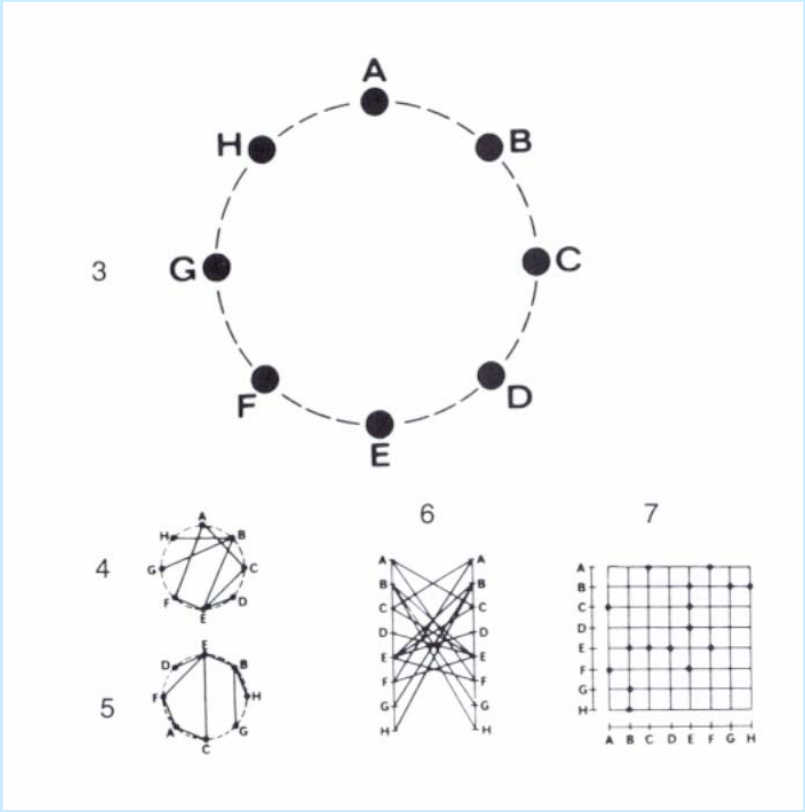
1. record correspondences
2. deduce simplest structure

fig. 3 - all components capable of conversing

fig. 4 - recording information

fig. 5 - organizing spatially

Supposing one group speaks, one listens -> diagrams such as fig. 6 or fig. 7.

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# Third group: Maps

- When correspondences can be established among
  - all the divisions of the same component
  - and can be arranged according to geometric order

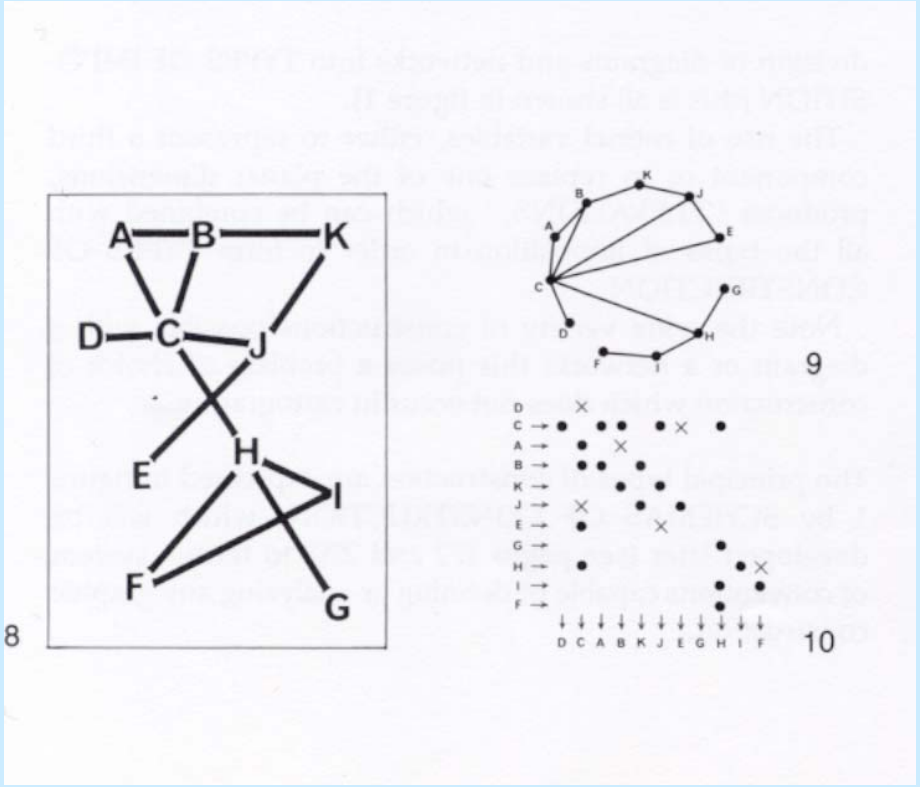
steps

1. Reproduce geometric order
2. record correspondences

fig. 9 - map of towns and roads

fig. 10 - network of this information

fig. 11 - diagram of this information

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# Fourth group: Symbols

- When correspondences are not established in the representation but between the marks in the representation and the reader
  - learned
  - culturally tied - meaning comes from agreement

- diagrams, networks , maps support internal processing
- symbolism (language) relies on external processing

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# Other groups: ?????

- Are there other basic groupings?
  - that are not just a combination of these four?
- Depiction (realistic representation)
- Historically,
  - symbolism,
  - depiction
  - maps
  - diagrams
  - networks
- question - as we go through recent work, will any constitute a new grouping, why?

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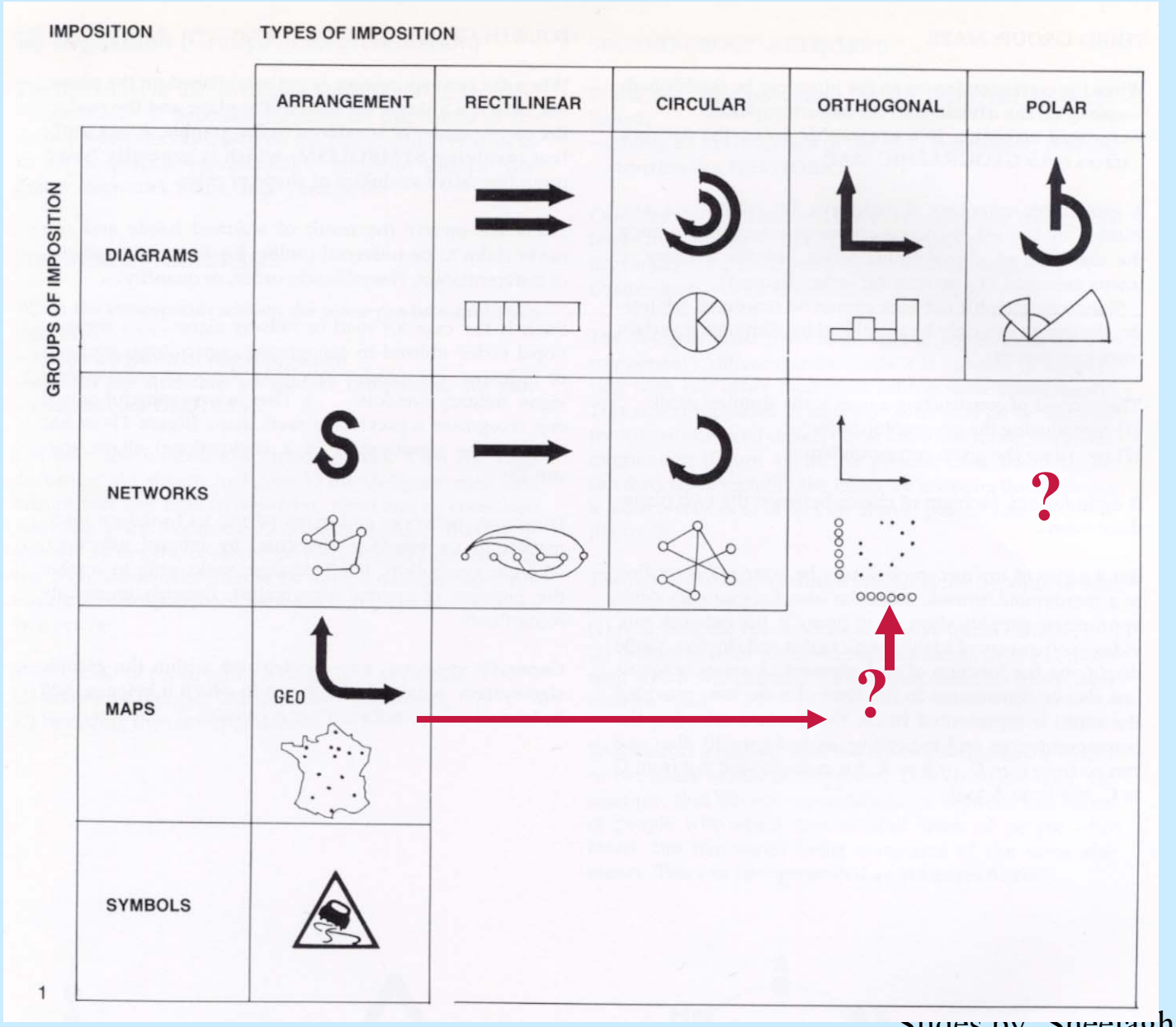
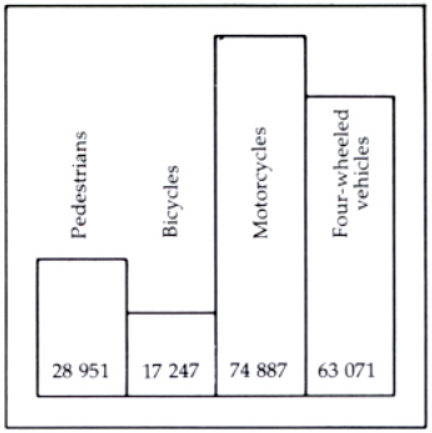
# Use of Space

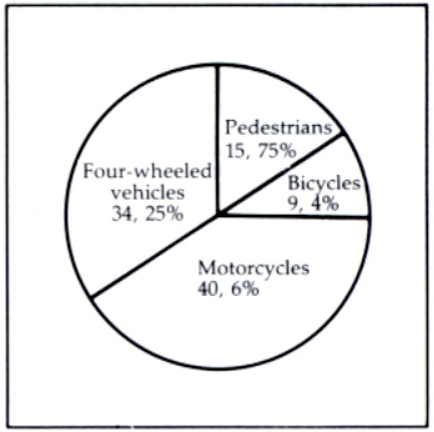

IMPOSITION
TYPES OF IMPOSITION
ARRANGEMENT
RECTILINEAR
CIRCULAR
ORTHOGONAL
POLAR
GROUPS OF IMPOSITION
DIAGRAMS
NETWORKS
MAPS
SYMBOLS
GEO
?
?
1

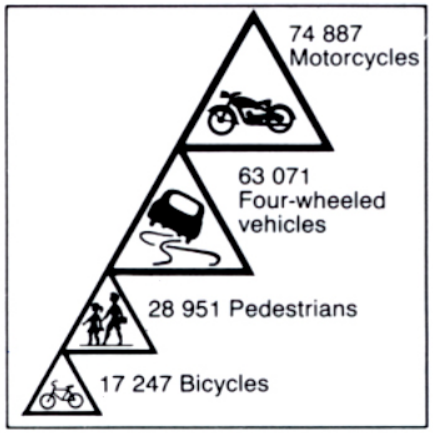
# Traffic accident victims France 1958

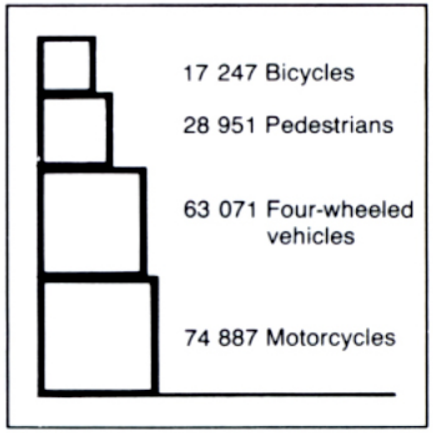
| | |
|---|---|
| pedestrians | 28,951 |
| bicycles | 17,247 |
| motorcycles | 74,887 |
| 4 wheel vehicles | 63,071 |

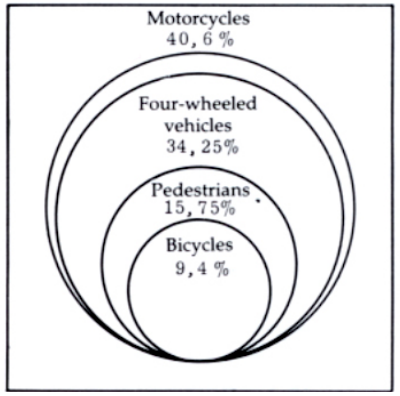
# Traffic accident victims France 1958

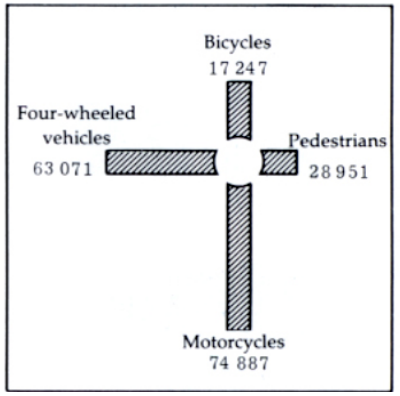


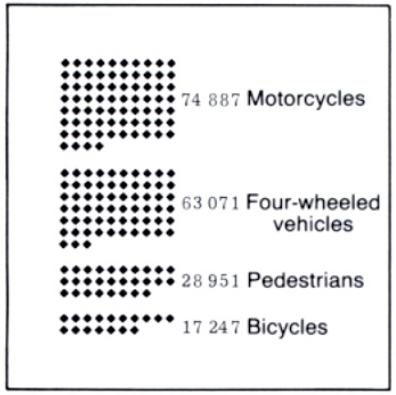



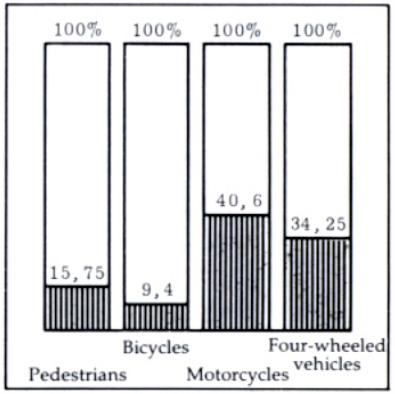



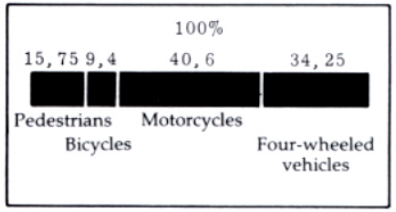



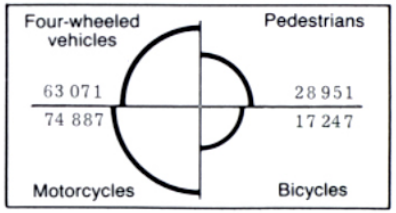

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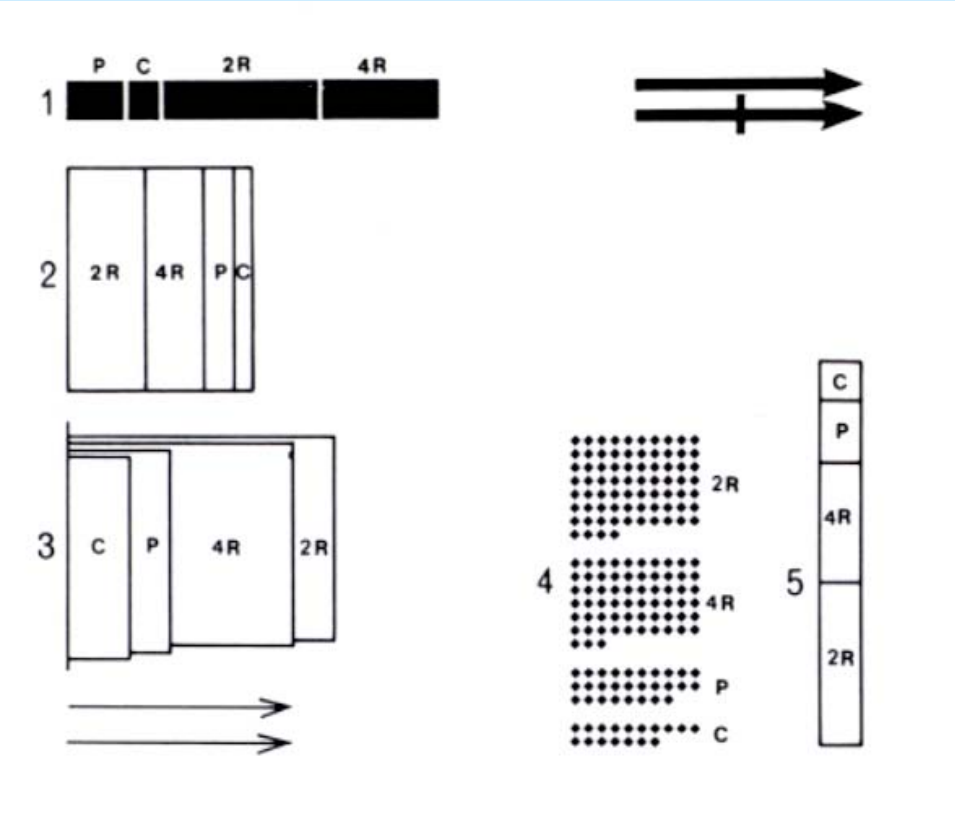
# Linear Construction

- Straight line represents the total
- quantities are shown proportionally
  - fig 1 - as given
  - fig 2 - sorted horizontal
  - fig 5 - sorted vertical
  - fig. 3 - spatially proportional - partial quantities related to same base
  - fig 4. - countable representation
- uses only 1 dimension of the plane - leaves the other free for ...

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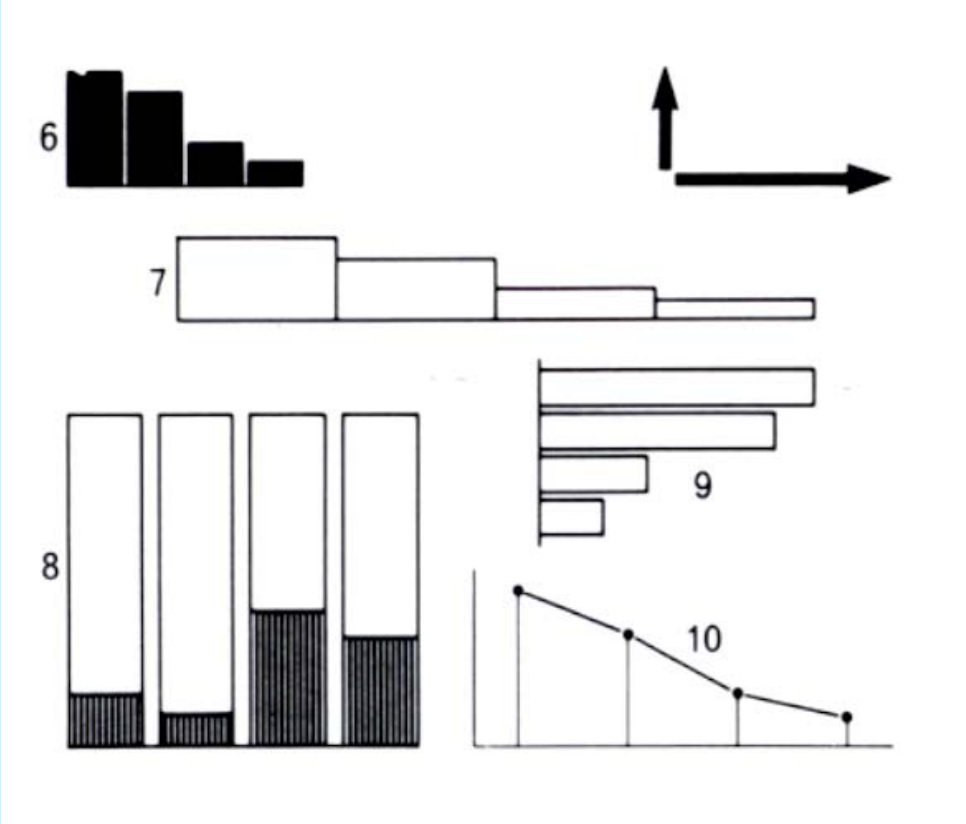
# Orthogonal Construction

- Spatial differentiation of parts
- juxtapose categories with quantity
  - fig 6, 7 - categories horizontal, quantities vertical
  - fig 9 - categories vertical
  - fig 8 - proportion as % emphasized
  - fig. 10 - linked categories … trends
- total is not portrayed but separate quantities easier to compare

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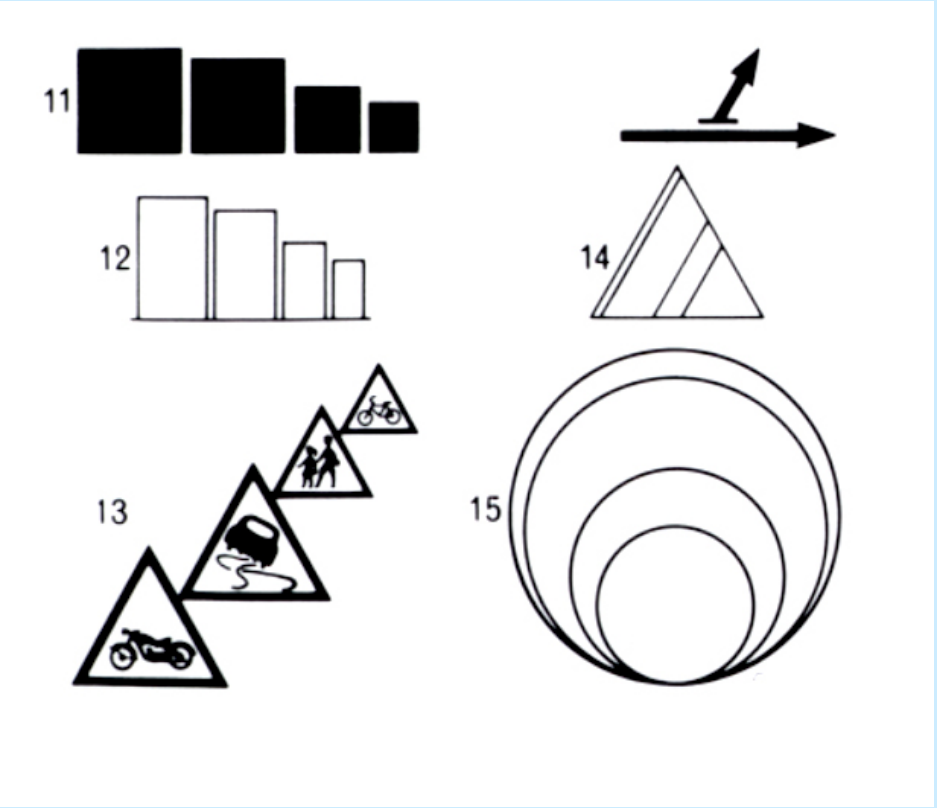
# Rectilinear Elevation

- Quantity is represented by area
- 2nd dimension is not used, variation in marks (vv -size) is used
  - fig 11, 12 - areas lined up horizontally
  - fig 13 - diagonal arrangment
  - fig 14, 15 - superimposed
- total is not portrayed but comparison of parts more difficult

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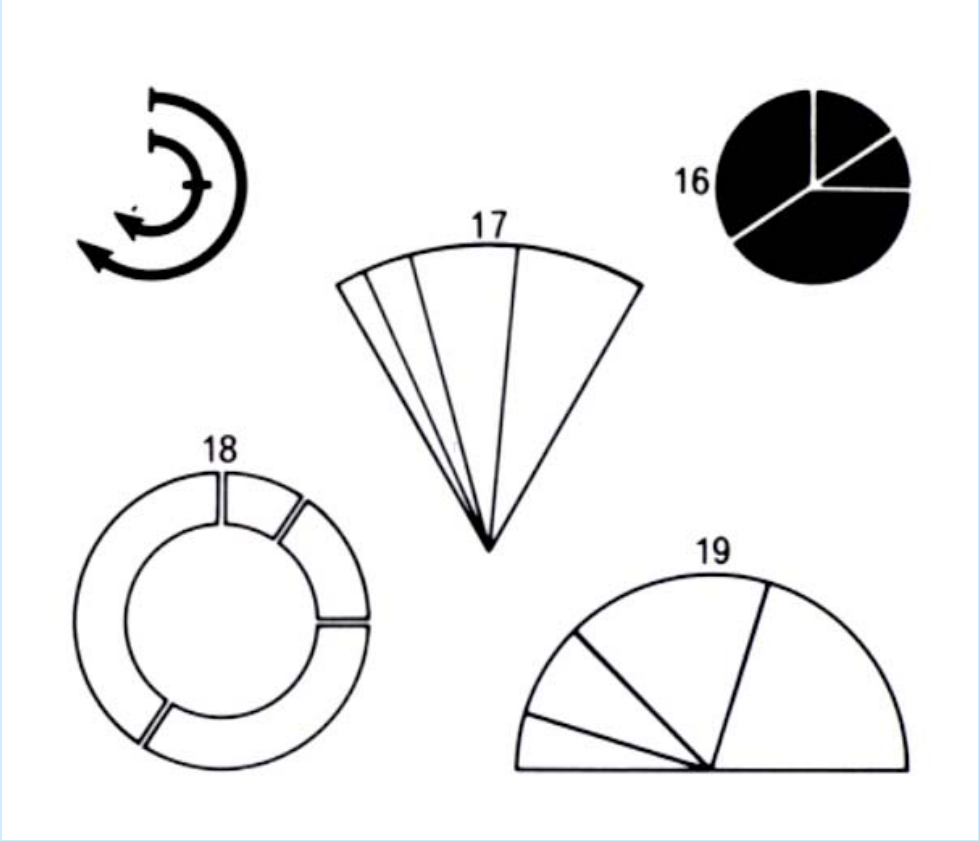
# Circular Construction

- Circular version of rectilinear construction
- total is portrayed
- amounts designated by angle at centre and length of

  circumference
  - fig 18, is fig. 5 curved
  - fig 16, 17, 19 - portion or whole circle

- comparing centre angles is easier than circumference lengths (fig 19 vs fig 18)

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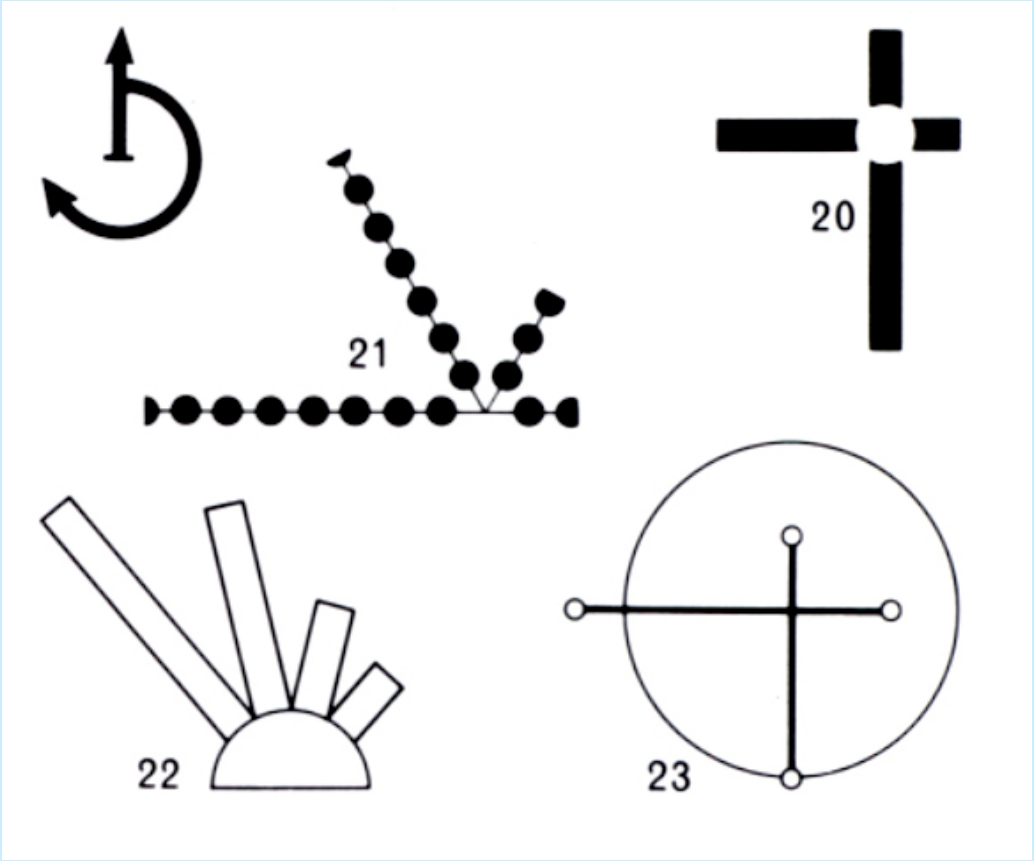
# Polar Construction

- Polar construction is a circular version of orthogonal construction
  - fig. 20, is fig. 6 curved
  - fig. 23 - visual measure of quantity added

- total not portrayed
- parts less easily comparable

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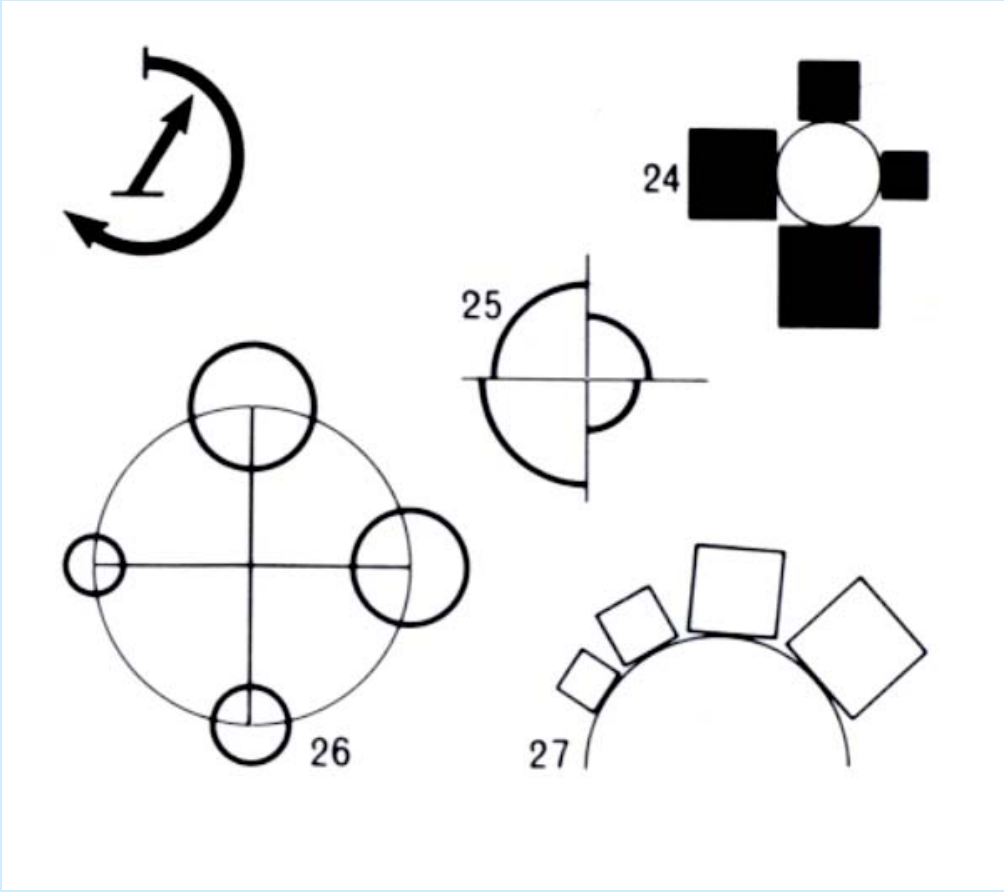
# Circular Elevation

- As in rectilinear elevation areas are proportional to quantity
  - fig. 24, is fig. 11 curved
  - fig. 27 - uses area, fig 22. - uses length
  - fig. 26 area of circle, fig 23 - length of line
  - fig 25. - Nightingale Rose

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# References


- Jacques Bertin, Semiology of Graphics: Diagrams, Networks, Maps. Translated by W. J. Berg. University of Wisconsin Press 1983 (in french 1967)
- John Fiske, Introduction to Communication Studies. (2nd edition). Routledge, London. 1991.