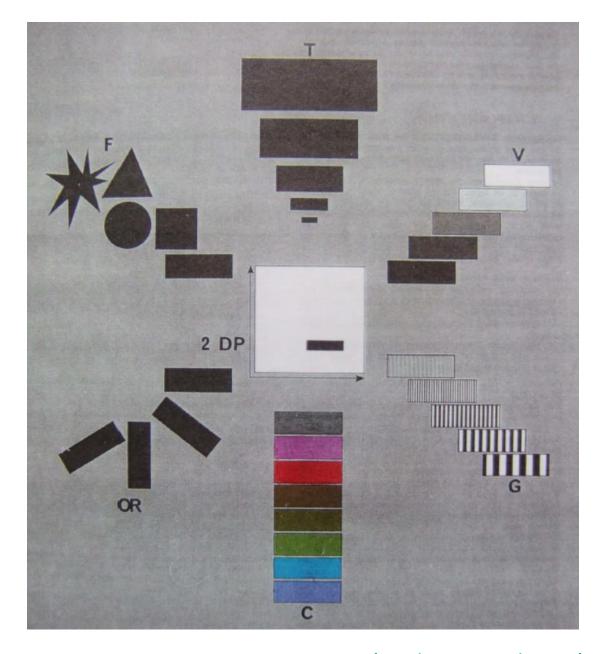
Glyphs

Bertin's Visual Variables

- Location variables (position, relative to a coordinate frame)
 - e.g. horizonal and vertical axes on a scatterplot; longitude and latitude on a map
 - (so fundamental to presenting map information that these variables are often ignored in cartography)
- Retinal variables (perceptual properties)
 - ways of representing differences between objects
 - size, shape, colour (hue), colour (value), texture, orientation

This separation makes clear the difference between the spatial relationships between symbols and the perceptual properties of the symbols themselves

- Location variables
 - fix a 'graphic mark' (symbol, visual object) on to a position on the plane
- Retinal variables
 - 'elevate' that mark with a different 'pattern of light'



Deux Dimensions du Plan Taille Valeur Grain Couleur Orientation

Forme

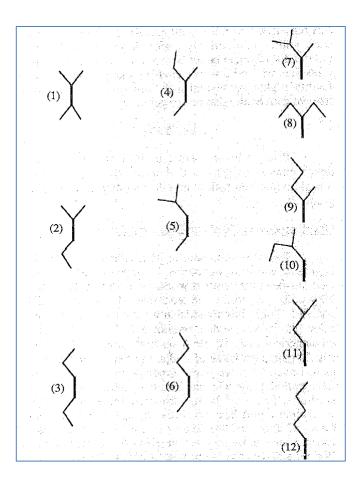
Two Dimensions on the Plane Size Colour (value) Texture Colour (hue) Orientation Shape

Bertin, Sémiologie Graphique (1967)

Representing multi-dimensional data with Glyphs

- A glyph is a visual object representing a single multi-dimensional data point
- The values of the different (retinal) visual variables in the glyph represent the values of the different dimensions
- The values of the two (*location*) variables add spatial dimensions to the visualization – by placing glyphs at different positions

Four dimensions: retinal visual variable (orientation)



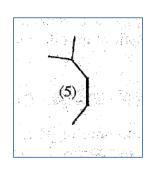
The "body" is always vertical

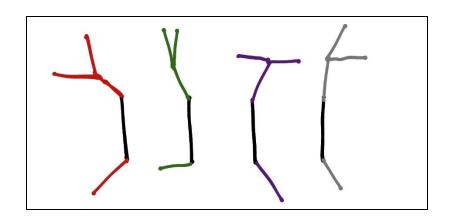
There are four "limbs" that can be drawn at different angles

Any of these 12 glyphs can be chosen to represent data of four dimensions

The angle of each limb represents a dimension value

(If the body is angled too, then five dimensions can be represented)

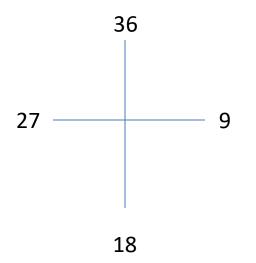




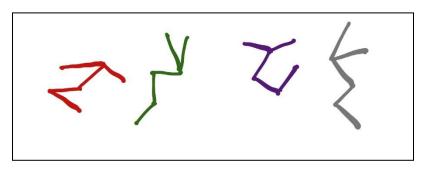
Four hill runners

The angle of each line - at the point of connection - shows the distance they ran on each of four days [1..36km] (working from left clockwise)

Colour indicates age group



	Day 1	Day 2	Day 3	Day 4	category
Α	28	35	12	21	U21
В	35	2	16	26	MOpen
С	28	9	20	16	F40
D	4	9	18	16	M50



Adding the *Location* visual variable

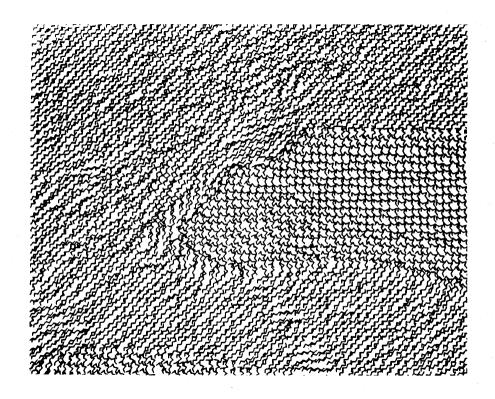
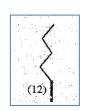


Figure 2. An iconographic display of multispectral imagery data from the NOAA-7 AVHRR weather satellite. Five channels of data control the orientations of the limbs in the stick-figure icon that forms each pixel.

Using glyph number 12, with body orientation



"Five channels of data from [a weather] satellite"

The western end of Lake Ontario and part of the eastern tip of Lake Erie



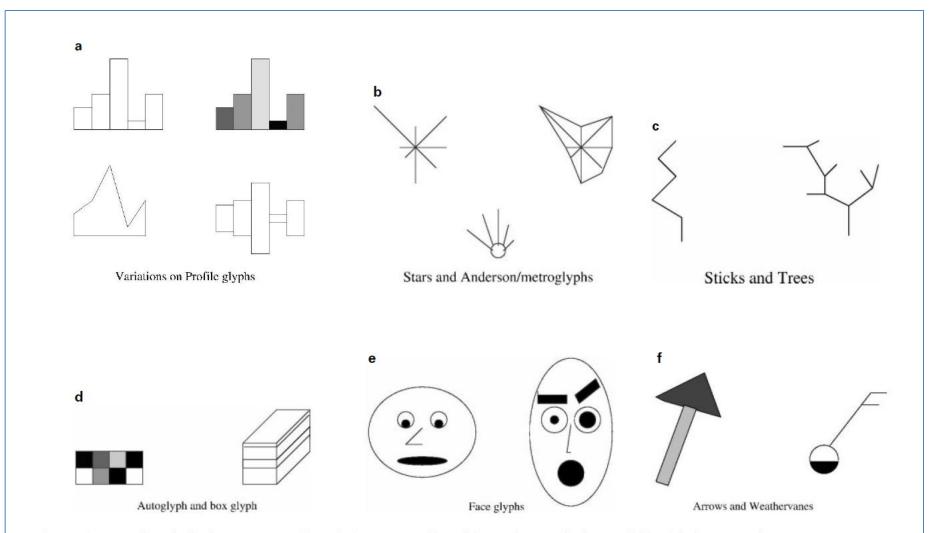
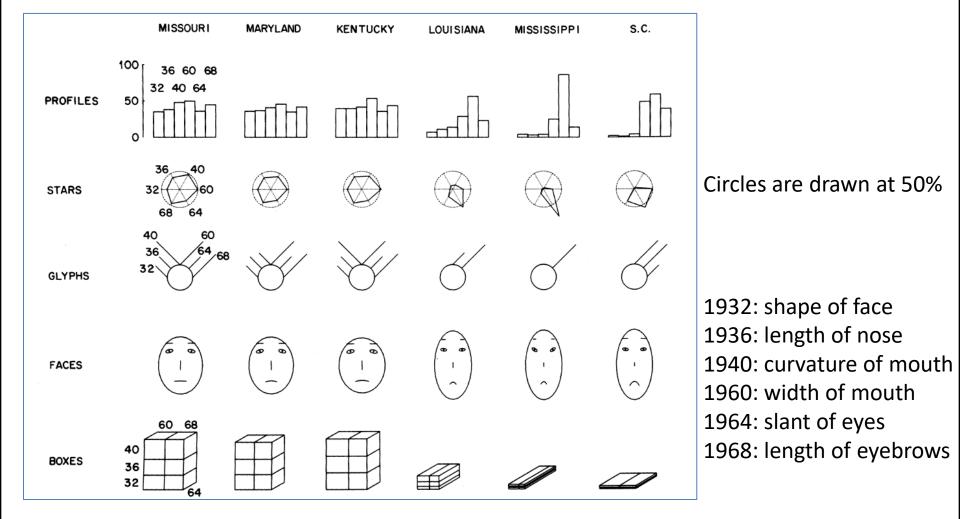


Figure 1 Examples of glyphs. Top row: (a) variations on profiles; (b) stars/metroglyphs; and (c) stick figures and trees. Bottom row: (d) autoglyphs and boxes; (e) faces; and (f) arrows and weathervanes.



Percentage of Republican votes in six Presidential Elections (1932-1968) in six Southern states

Chernoff faces

Six measurements on 87 fossils:

- Z₁ inner diameter of embryonic chamber (in microns)
- Z₂ total number of whorls
- Z₃ number of chambers in first whorl
- Z₄ number of chambers in last whorl
- Z₅ maximum height of chambers in first whorl (in microns)
- Z₆ maximum height of chambers in last whorl (in microns)

ID	$^{\mathrm{Z}}$ ı	\mathbf{z}_2	^Z 3	z_4	^Z 5	^z 6
1 2 3 4 5	160 155 141 130 161	51 52 49 50 50	10 8 11 10	28 27 25 26 27	70 85 72 75 70	450 400 380 560 665

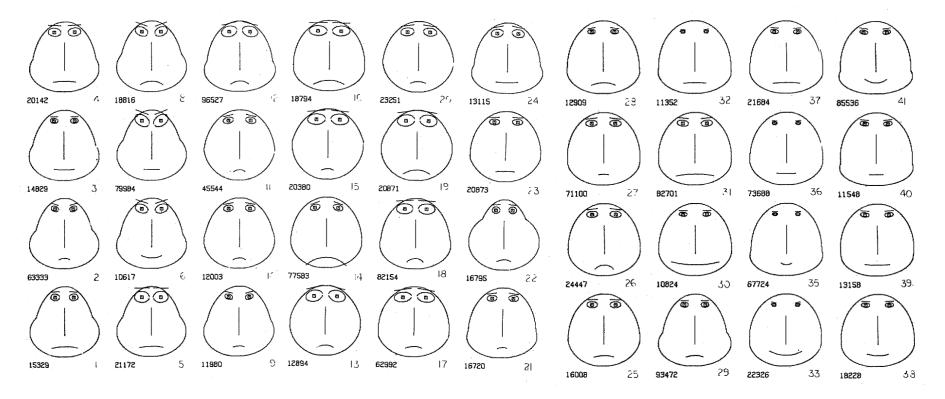
"People grow up studying and reacting to faces all of the time.

Small and barely measurable differences are easily detected and evoke emotional reactions from a long catalogue buried in the memory.

Relatively large differences go unnoticed in circumstances where they are not important.

This implies that the human mind sub-consciously operates as a high-speed computer, filtering out insignificant visual phenomena and focusing on the potentially important.

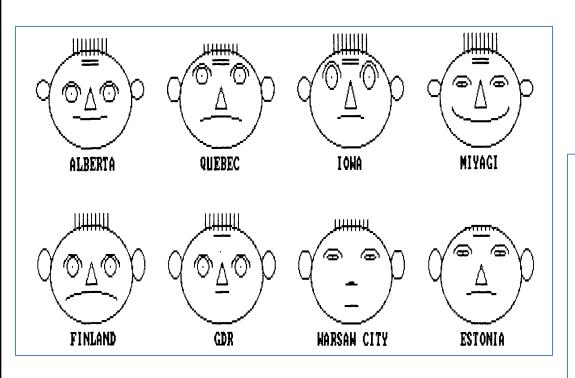
Particularly valuable is this flexibility in disregarding non-informative data and searching for useful information."



Visual clustering shows seven different groups of fossils:

- I: (1, 2, 3, 9, 22, 29)
- II: (4, 5, 6, 7, 8)
- III: (10, 11, 14, 23, 25, 26, 27)
- IVa: (13, 15, 16, 17, 18, 19, 20)
- IVb: (12, 24)
- V: (21, 28, 30, 31, 37, 38, 39, 40, 41)
- VI: (32, 33, 35, 36)

Lung cancer incidence (males 1968-1972)



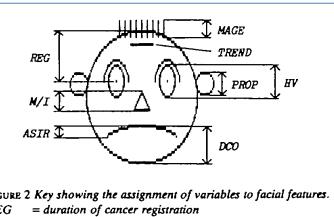


FIGURE 2 Key showing the assignment of variables to facial features.

REG

= mortality/incidence ratio MII

ASIR = age-standardized incidence rate

MAGE = mean age at diagnosis TREND = time trend in incidence PROP = proportion of incident cases HV= histological verification

= death certificate only diagnosis DCO

Placement of glyphs

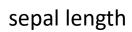
- A single glyph only represents one data point
- A data set is therefore represented by several glyphs
- They need to be placed on the plane, where their position in relation to each other:
 - does not matter
 - relates to an 'information' dimension
 - relates to a 'spatial' dimension

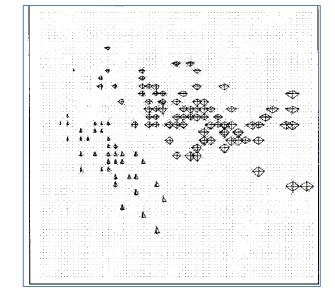
Information location:

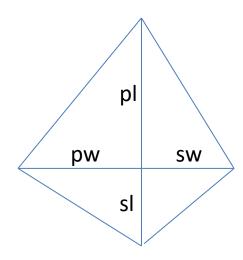
using two (represented) dimensions - star glyphs

Iris data set:

petal length, petal width, sepal length, sepal width





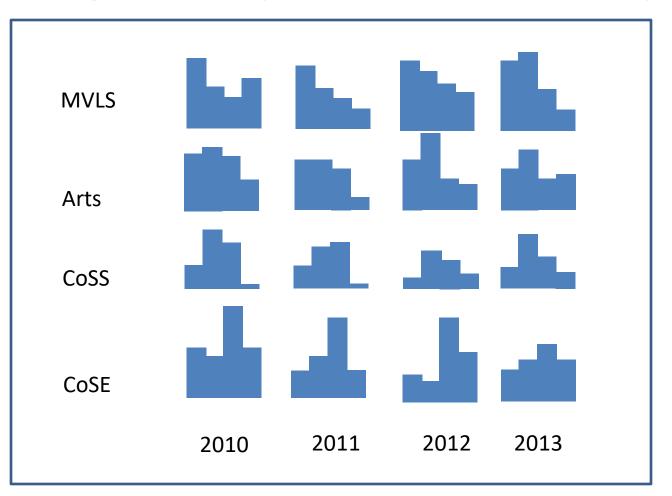


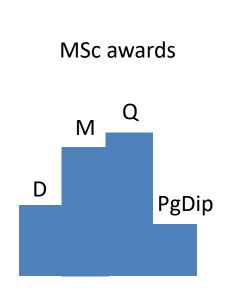
sepal width

(five other sctterplot pairwise configurations possible)

Information location:

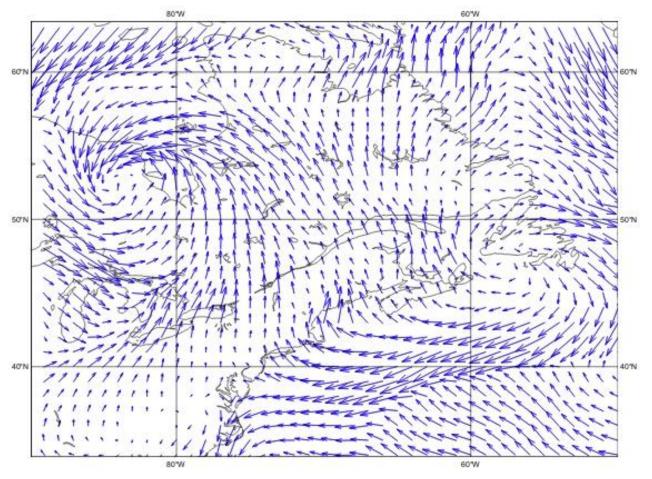
using two (unrepresented) dimensions – profile glyphs





Spatial location:

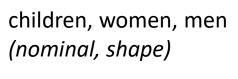
using geographic co-ordinates – arrow glyphs



Members of a running club

Best race finishing position	country	category	count
2	Ireland	men	2
3	Scotland	men	3
4	England	women	4
5	Wales	men	4
6	Scotland	men	3
7	Wales	men	4
8	Ireland	women	1
9	Ireland	men	4
10	Scotland	women	8
11	Scotland	men	8
35	England	women	4
51	Scotland	child	1

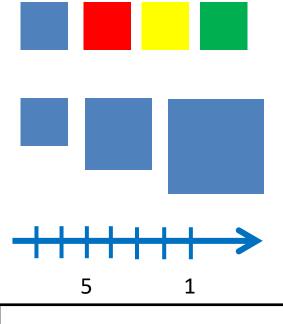


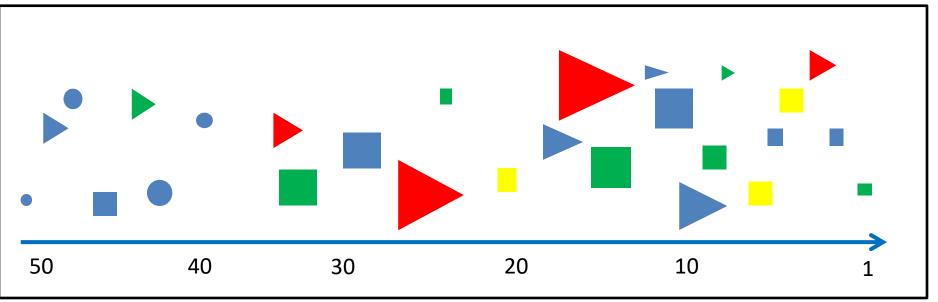


Scotland, England, Wales, Ireland (nominal, hue)

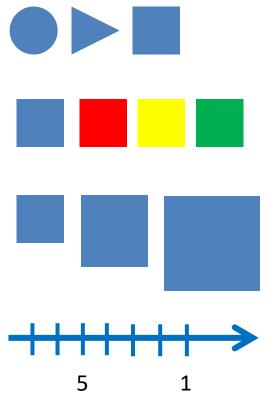
number of runners: 10, 50, 100 (ordered & quantitative, area)

best race finishing position (ordered & quantitative, horizontal position)





Members of a running club



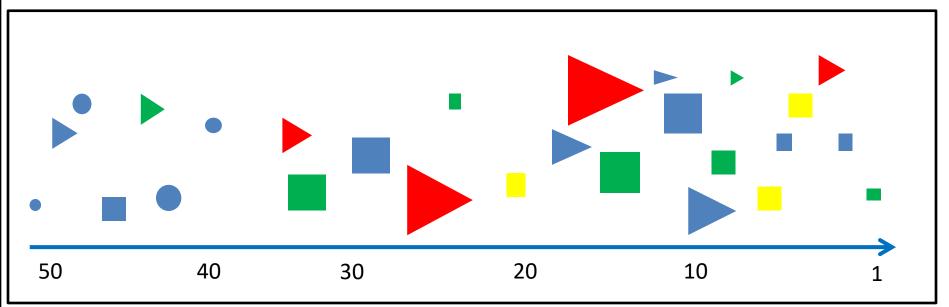
children, women, men (nominal, shape)

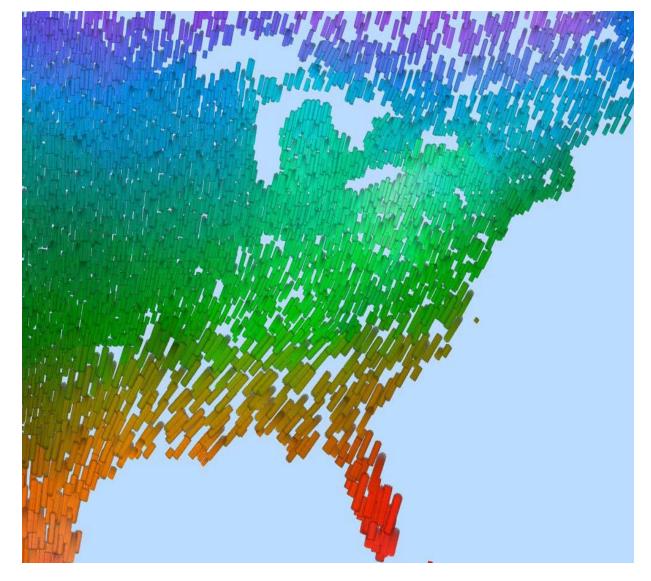
Scotland, England, Wales, Ireland (nominal, hue)

number of runners: 10, 50, 100 (ordered & quantitative, area)

Interaction between shape and size?

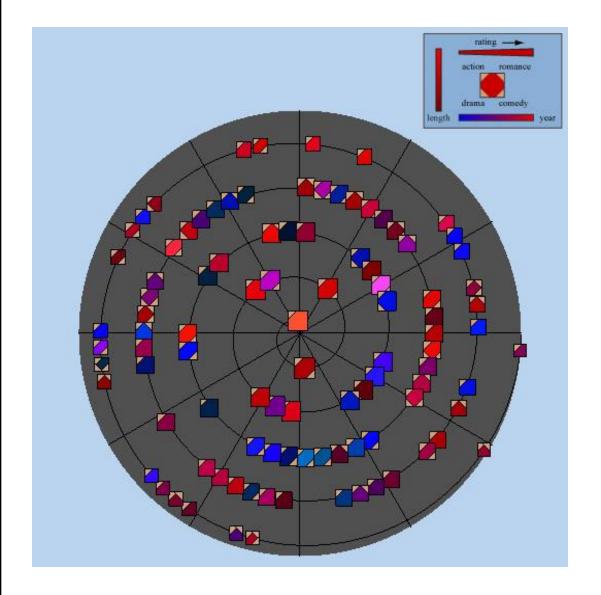
best race finishing position (ordered & quantitative, horizontal position)





Weather:

temperature → hue wind speed → density pressure → size precipitation → orientation cloud coverage → luminance



Sawant, A. P. and Healey, C. G. (2008). "Visualizing Multi-dimensional Query Results Using Animation," *Proceedings Visualization and Data Analysis (VDA 2008), San Jose, California, Vol. 6809, paper 04, pp. 1-12*

Movie recommendations

Ranks (location)

High rank in the middle Lower rank near the periphery

Predicted user rating (size)

Large: high ratings Small: low ratings

Year (colour hue)

Old: blue Recent: red

Length (colour value)

Dark: short Bright: long

Genre (shape – corner triangles)

Northeast: comedy Northwest: action Southwest: romance

Southeast: drama

Glyphs