

# Bertin's Visual Variables

- **Location** variables (position, relative to a coordinate frame)
  - e.g. horizontal 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

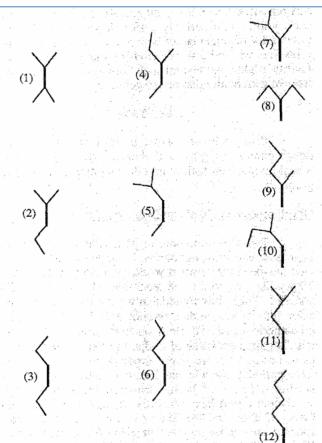
*This separation makes clear the difference between the spatial relationships between symbols and the perceptual properties of the symbols themselves*

- 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'

## 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)



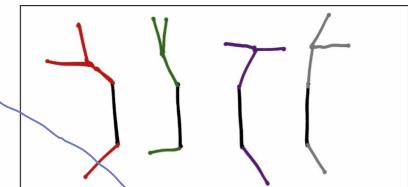
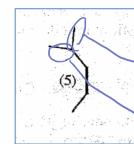
The "body" is always vertical

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

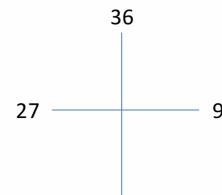
(If the body is angled too, then five dimensions can be represented)



Four hill runners

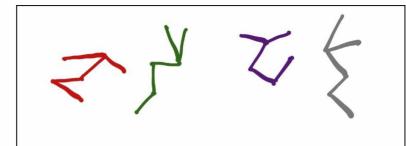
The angle of each line - at the point of connection - shows the distance they ran on each of four days [1..36km] (working from left clockwise)

Colour indicates age group

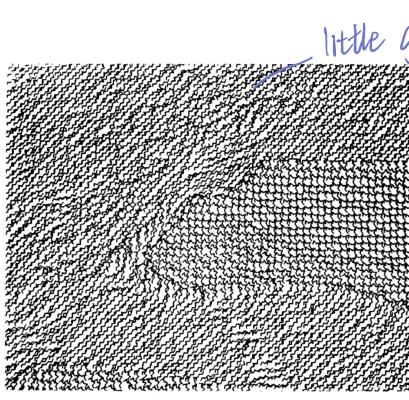


	Day 1	Day 2	Day 3	Day 4	category
A	28	35	12	21	U21
B	35	2	16	26	MOpen
C	28	9	20	16	F40
D	4	9	18	16	M50

need key / legend  
to explain how encoding



## Adding the Location visual variable



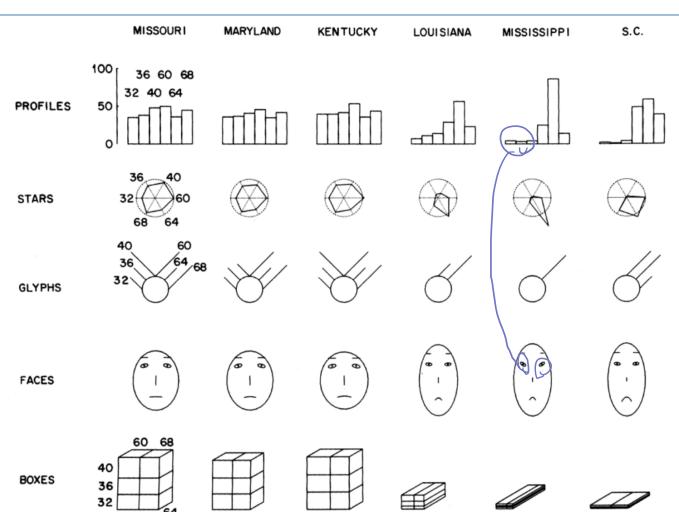
little glyphs

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



Circles are drawn at 50%

1932: shape of face

1936: length of nose

1940: curvature of mouth

1960: width of mouth

1964: slant of eyes

1968: length of eyebrows

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

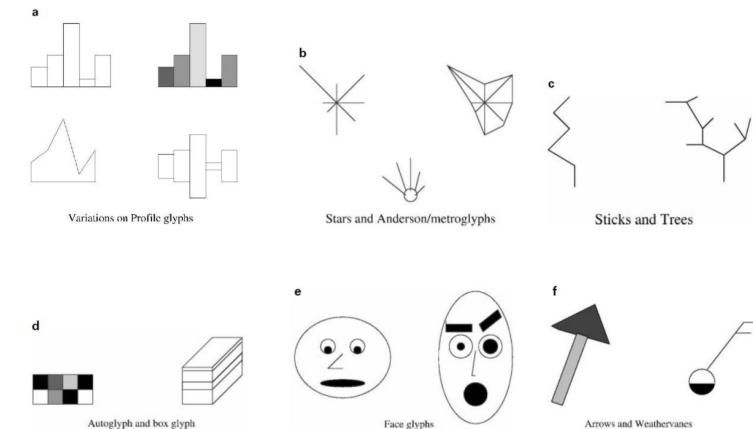


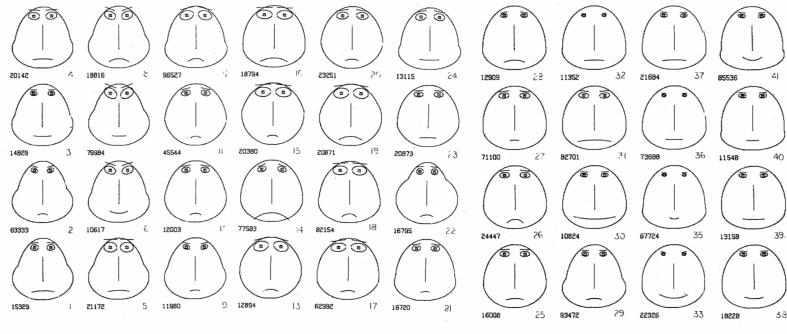
Figure 1 Examples of glyphs. Top row: (a) variations on profiles; (b) stars/metroglyphs; and (c) stick figures and trees. Bottom row: (d) autoglyphs and boxes; (e) faces; and (f) arrows and weathervanes.

# Chernoff faces

Six measurements on 87 fossils:

- $Z_1$  inner diameter of embryonic chamber (in microns)
- $Z_2$  total number of whorls
- $Z_3$  number of chambers in first whorl
- $Z_4$  number of chambers in last whorl
- $Z_5$  maximum height of chambers in first whorl (in microns)
- $Z_6$  maximum height of chambers in last whorl (in microns)

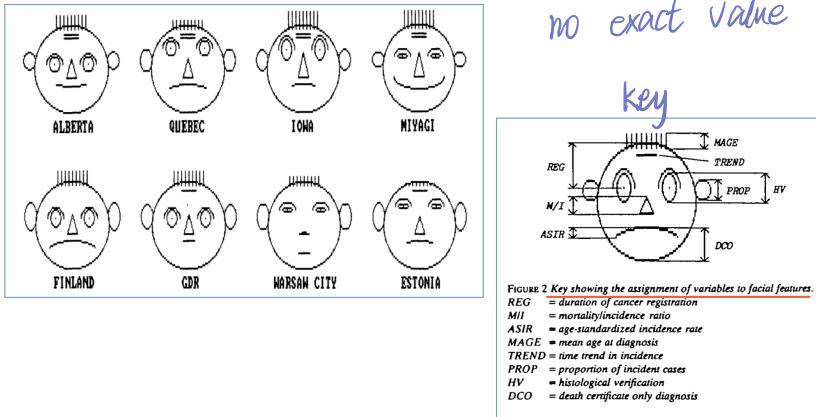
ID	$Z_1$	$Z_2$	$Z_3$	$Z_4$	$Z_5$	$Z_6$
1	160	51	10	28	70	450
2	155	52	8	27	85	400
3	141	49	11	25	72	380
4	130	50	10	26	75	560
5	161	50	10	27	70	665



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)



place meaningless

# Placement of glyphs

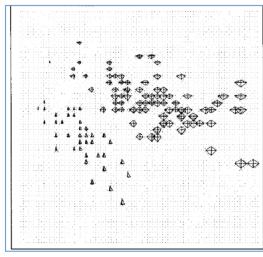
- A single glyph only represents *one data point*
- A data set is therefore represented by *several glyphs*
- They need to be placed on the plane, where their position in relation to each other:
  - does not matter *face*
  - relates to an ‘information’ dimension
  - relates to a ‘spatial’ dimension

## Information location:

using two (represented) dimensions - star glyphs

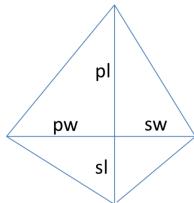
Iris data set:

petal length, petal width, sepal length, sepal width

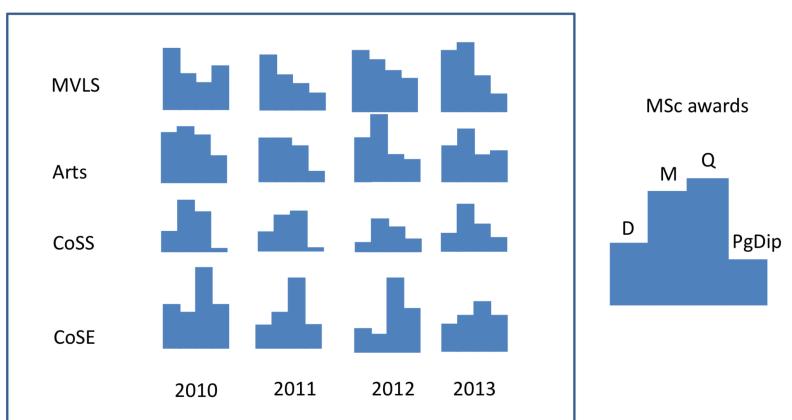


sepal width

(five other scatterplot pairwise configurations possible)

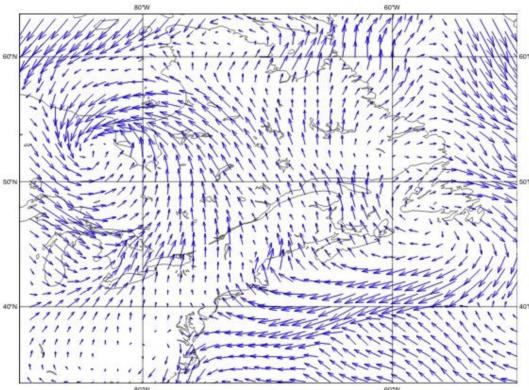


using two (unrepresented) dimensions – profile glyphs



## Spatial location:

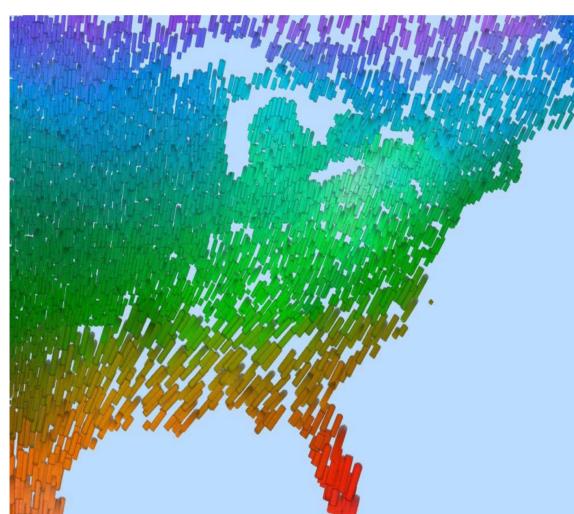
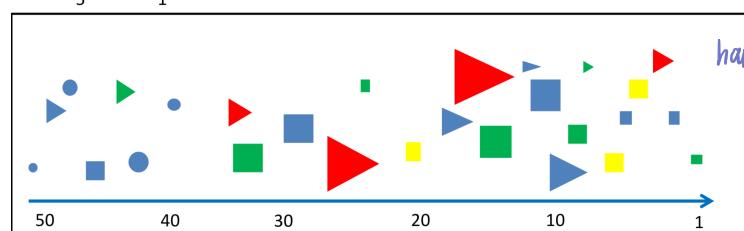
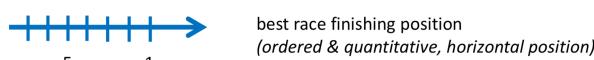
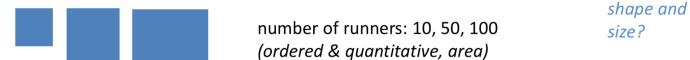
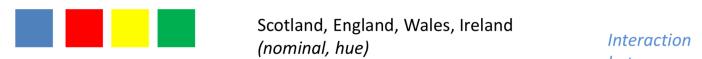
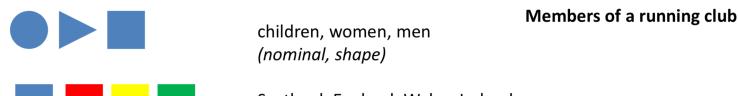
using geographic co-ordinates – arrow glyphs



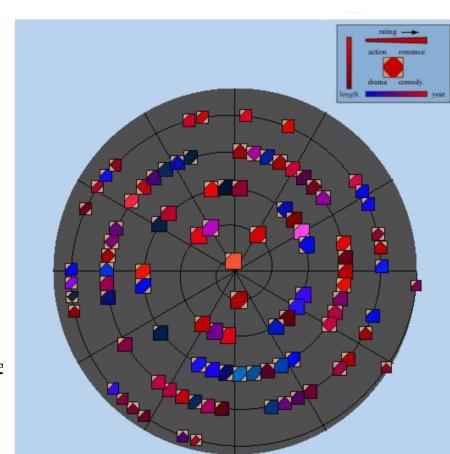
# Members of a running club

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

how to put into glyphs



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



**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

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