

VARIABLES TO REPRESENT DATA

Marks

Marks are basic geometric elements that depict items or links, and channels control their appearance.

→ Points



→ Lines



→ Areas

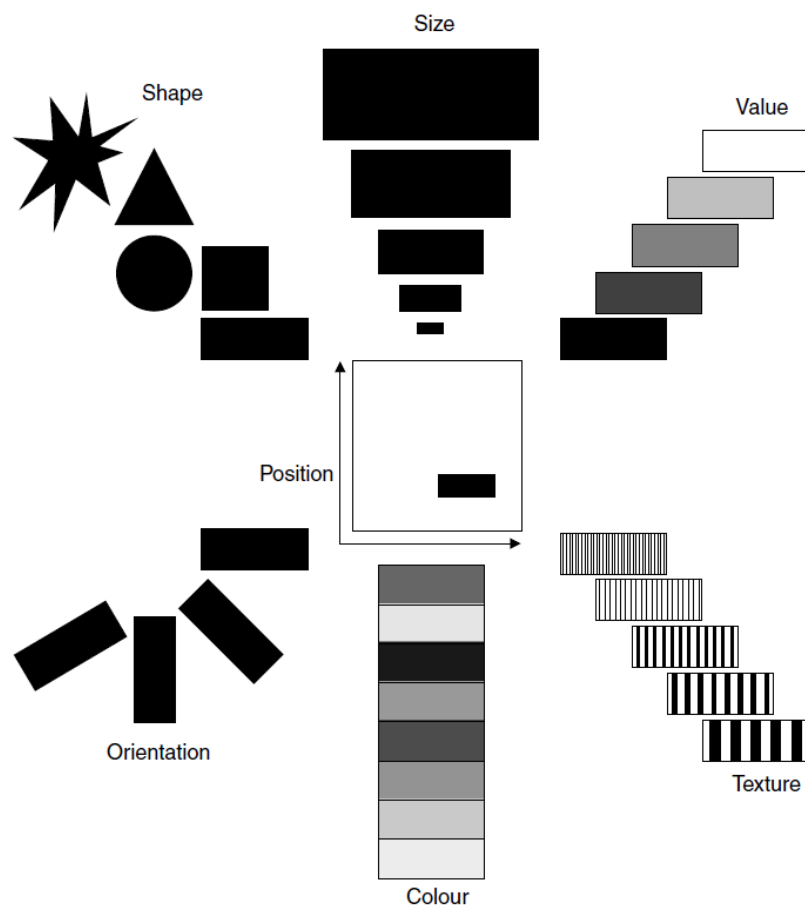


Note: Surface and Volume can be considered marks as well [2]. However, they are less common.

Visual Variables—Bertin















Visual variables are the aspects of a mark that can visually differentiate it from other marks, and can be controlled during the design process [1].

Bertin introduced the following variables:



Channels—Munzer

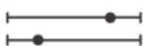
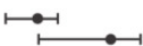






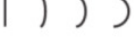

Channels are similar to the variables, as they control the appearance of a mark [3].

Position on common scale		Spatial region	
Position on unaligned scale		Color hue	
Length (1D size)		Motion	
Tilt/angle		Shape	
Area (2D size)			
Depth (3D position)			
Color luminance			
Color saturation			
Curvature			
Volume (3D size)			





The effectiveness of a channel depends on its type: channels that convey magnitude information suit ordered data well, whereas those that convey identity information suit categorical data.

Channels: Expressiveness Types and Effectiveness Ranks

➔ Magnitude Channels: Ordered Attributes

Position on common scale	
Position on unaligned scale	
Length (1D size)	
Tilt/angle	
Area (2D size)	
Depth (3D position)	
Color luminance	
Color saturation	
Curvature	
Volume (3D size)	

➔ Identity Channels: Categorical Attributes

Spatial region	
Color hue	
Motion	
Shape	

Most
Effectiveness
Least

Same
Same

Motion and Characteristics—Carpendale

According to Carpendale, the following dimensions of motion can be used to encode data [2]:

1. Direction
2. Speed
3. Frequency
4. Rhythm
5. Flicker
6. Trails
7. Style

Variables / channels can have the following characteristics:

- **Selective:** a variable/channel is selective when changing the mark using the visual variable/channel, makes it easier to select the mark (e.g., a canvas with dots, of which the size of 1 dot is enlarged).
 - * *Is a mark distinct from other marks?*
 - * *Can we differentiate between 2 marks?*
- **Associative:** a variable/channel is associative when marks of different variables/channels (e.g., squares and circles) can be grouped together because of the used variable/channel (e.g., different shapes coloured yellow can be considered as a group).
 - * *Does the variable/channel support grouping?*
- **Quantitative:** a variable/channel is quantitative when the relation between two marks differing in this variable/channel can be seen as numerical (e.g., 1 line is perceived 4x bigger as the other line).
 - * *Can we quantify the difference between 2 marks?*
- **Order:** a variable/channel is quantitative when it allows for ordered readings (e.g., a gradient from red to green).
 - * *Does the variable/channel show a change in order?*
- **Length:** length of a variable/channel refers to the number of changes that can be used whilst retaining the task supporting characteristics of the variable (e.g., how many changes in value (shades of grey) can be recognised?).
 - * *How many unique marks can we make?*

Carpendale summarised the characteristics per variable/channel as follows:

Variable/Channel	Selective	Associative	Quantitative	Order	Length
Position	●	●	●	●	●
Size	●	●	sometimes	●	●
Shape	sometimes	sometimes	—	—	●
Value	●	●	—	●	●
Colour	●	●	—	—	●
Orientation	●	●	—	—	●
Pattern	sometimes	sometimes	—	—	●
Grain	●	●	—	—	●
Texture	●	●	—	—	●
Motion	●	●	—	●	●

Gestalt Principles

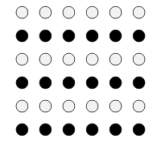
Gestalt principles which are often used (and extend to the physical realm):



principle of proximity



principle of closure



principle of similarity



principle of continuity



principle of figure and ground



principle of symmetry

Sources

1. Jacques Bertin. 1983. *Semiology of Graphics: Diagrams, Networks, Maps*. University of Wisconsin Press, Madison.
2. Sheelagh Carpendale. 2003. Considering Visual Variables as a basis for Information Visualisation. *Cartographica: International Journal for Geographic Information and Geovisualization* 43, 175–188. <https://doi.org/http://dx.doi.org/10.11575/PRISM/30495>
3. Tamara Munzner. 2014. *Visualization Analysis and Design*. A K Peters/CRC Press, Boca Raton. <https://doi.org/10.1201/b17511>