

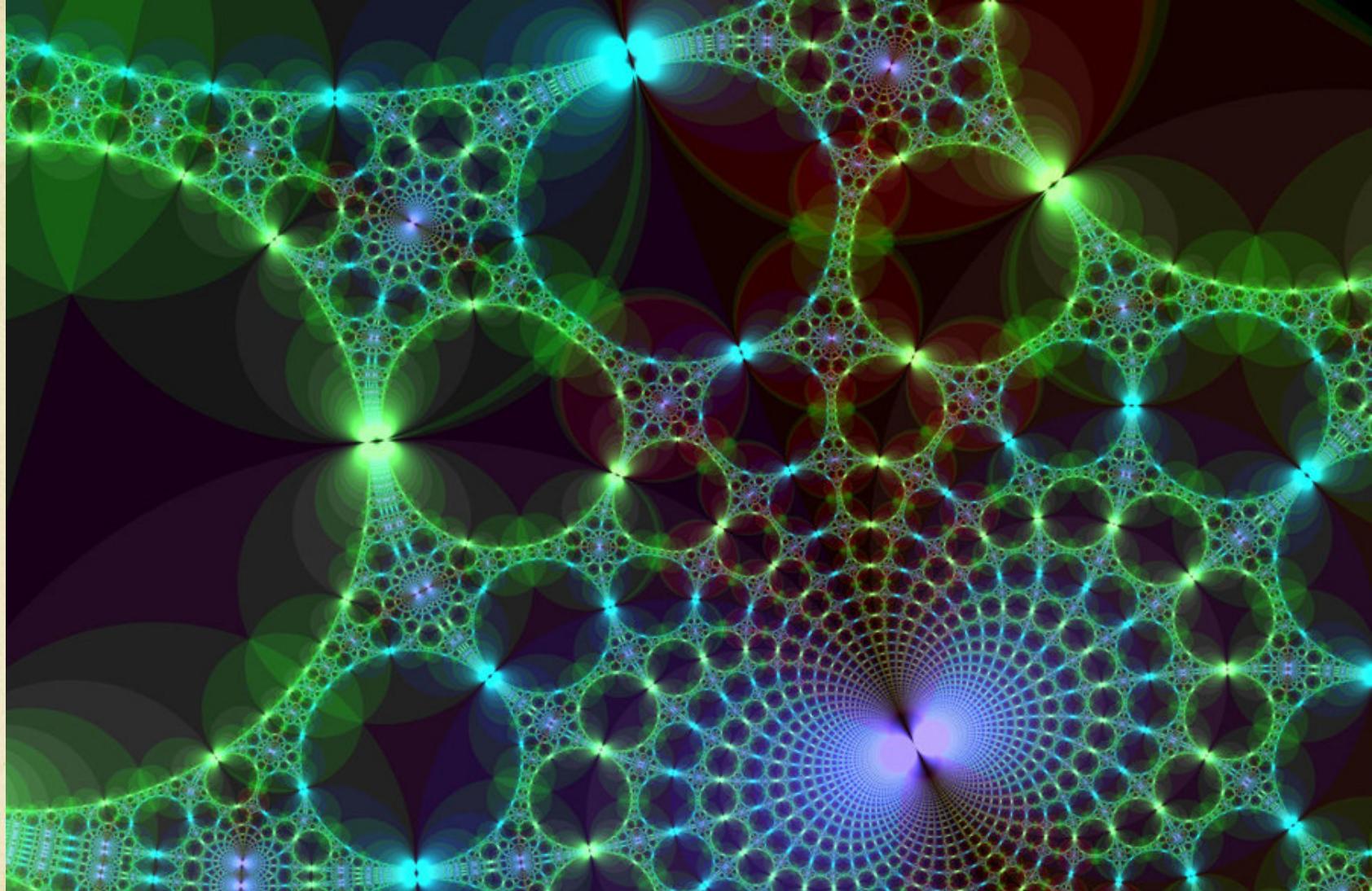


Visual Language

For education

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Dept. of EE & Engineering
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○ A picture is worth a thousand word

Contents

- Introduction of Visual Language
- Visual Encoding
- Visual Symbols
- Visual Grammar
- Practical exercise
- Summary



Visual Language

- Based on pattern perception
- No learned symbols
- Incorporates logic based on pattern, object, and space.
- Consists of spatially-based structural relationships.

Natural Language

- Based on nouns to denote objects & verbs to denote action (symbols)
- Incorporates a form of logic that provides for abstract reasoning
- Uses socially-designed tools for communication.
- Comprised of symbols and grammar known by all users.

Encoding

- Human encodes the world using **memory**.
- **Memory** has the ability to **encode**, store and recall information.
- Memories give an organism the capability to learn and adapt from previous experiences as well as build relationships.
- Encoding allows the perceived item of use or interest to be converted into a construct that can be stored within the brain[citation needed] and recalled later from short-term or long-term memory.

What we encodes

- **Acoustic Encoding**: the encoding of sound, especially the sounds of words.
- **Semantic Encoding**: the encoding of meaning

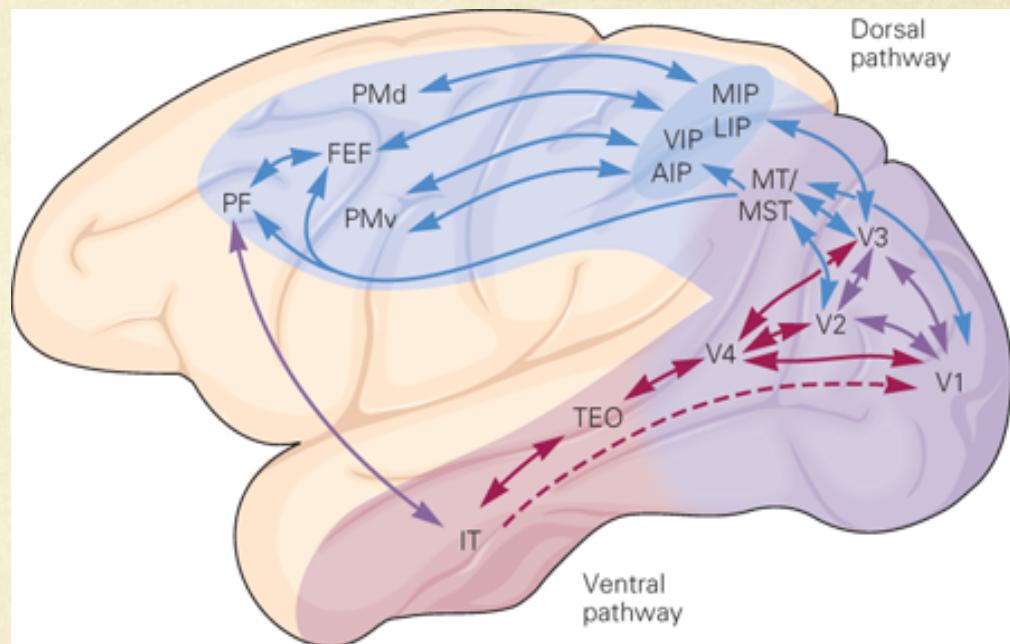
eg: Rambutan =



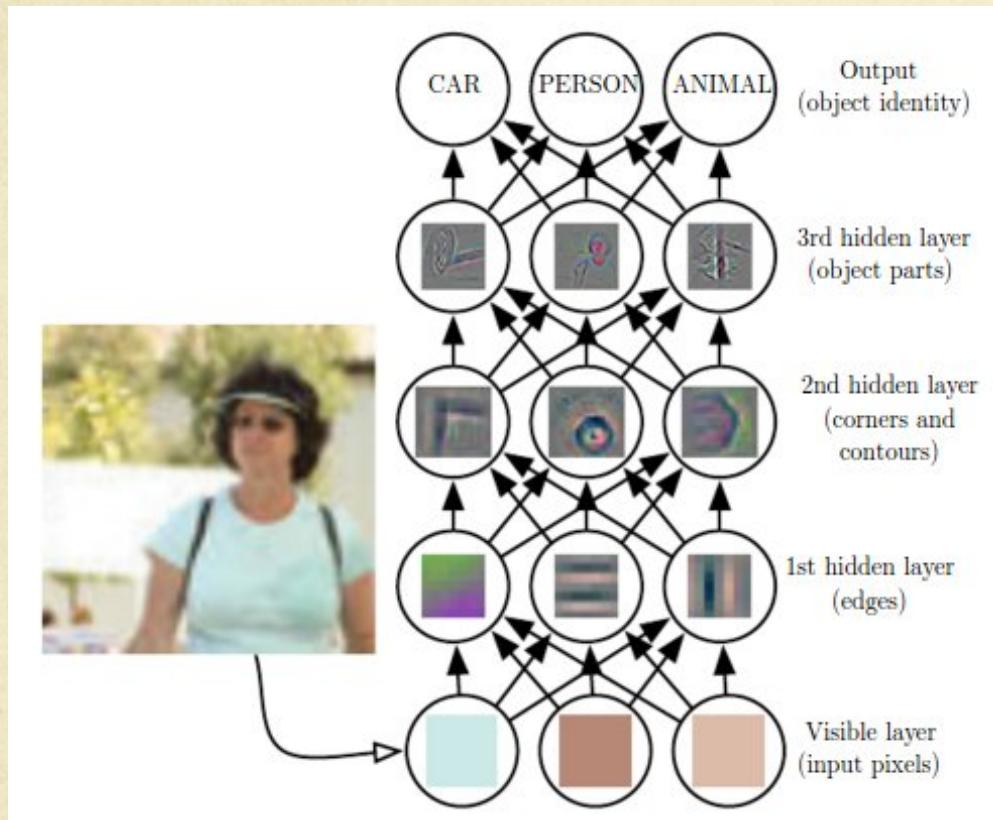
- **Visual Encoding**: the encoding of picture / visual images.

Visual Encoding

- **Visual encoding** is the process of encoding **images** and **visual sensory information**.
- **Visual encoding** is the way in which data is mapped into **visual structures**, upon which we build the images on a screen.

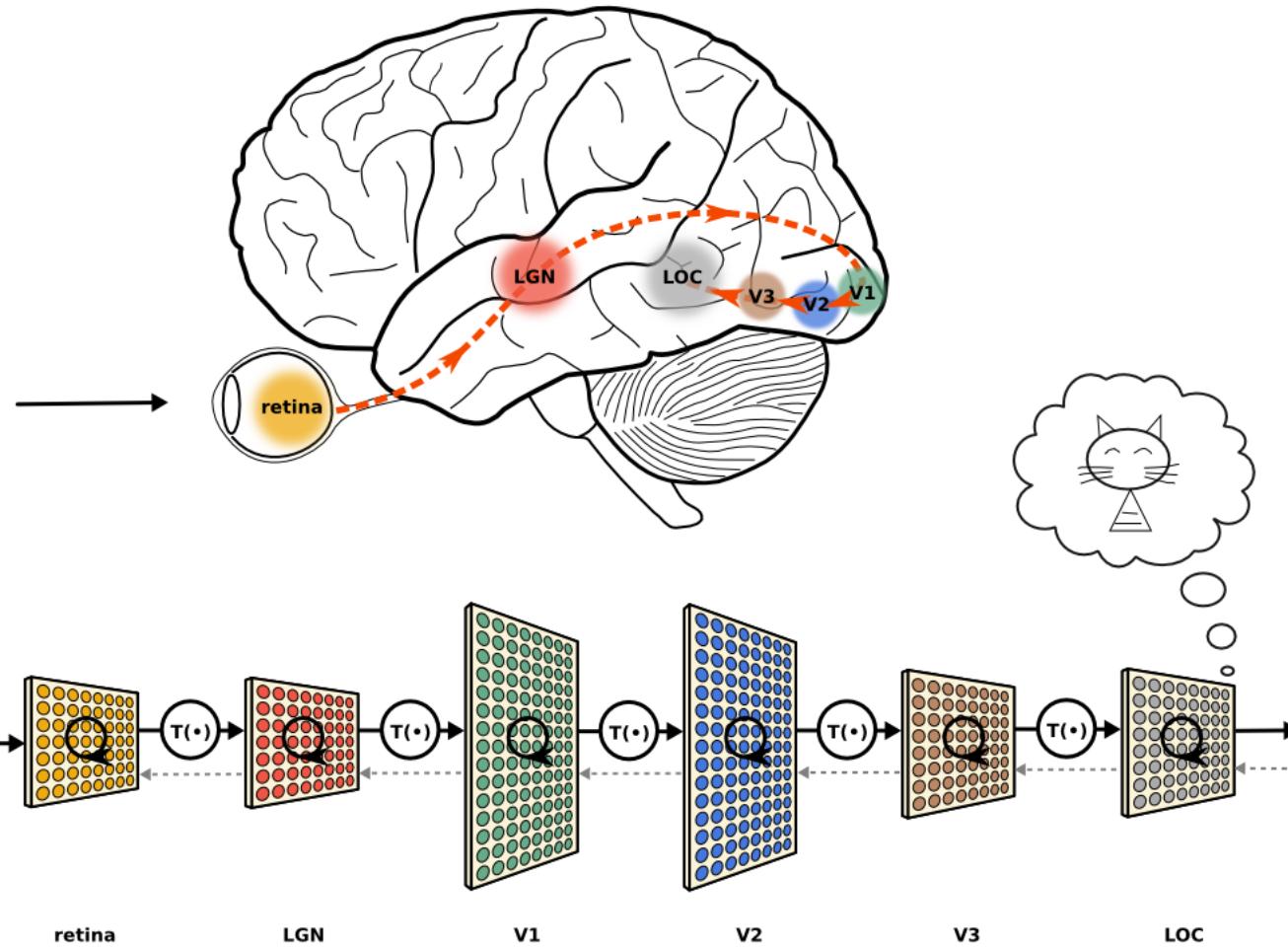


Visual Encoding



- Hierarchical
- Simple → Complex
- Pixel → Edges → Corner → Objects
Parts → Objects

Visual Encoding





Visual Thinking

- Visual symbols
(no meaning)
- Spaces and Patterns
- Visual Grammar

Language Thinking

- Letters and Words
(learned symbols)
- Sentences & Paragraphs
- Grammar

Visual: Data



Visual symbols

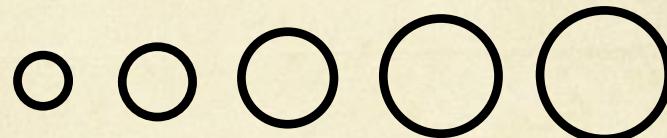
Language: Data



Letters & Words

Visual symbols

○ Size:



○ Orientation:



○ Saturation:



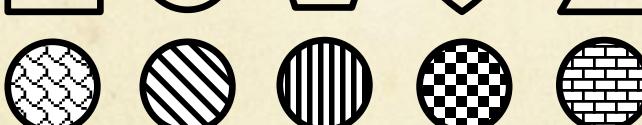
○ Density:



○ Hue:



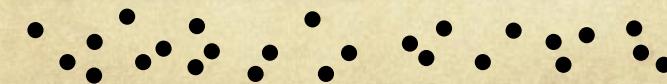
○ Shape:



○ Length:



○ Position:

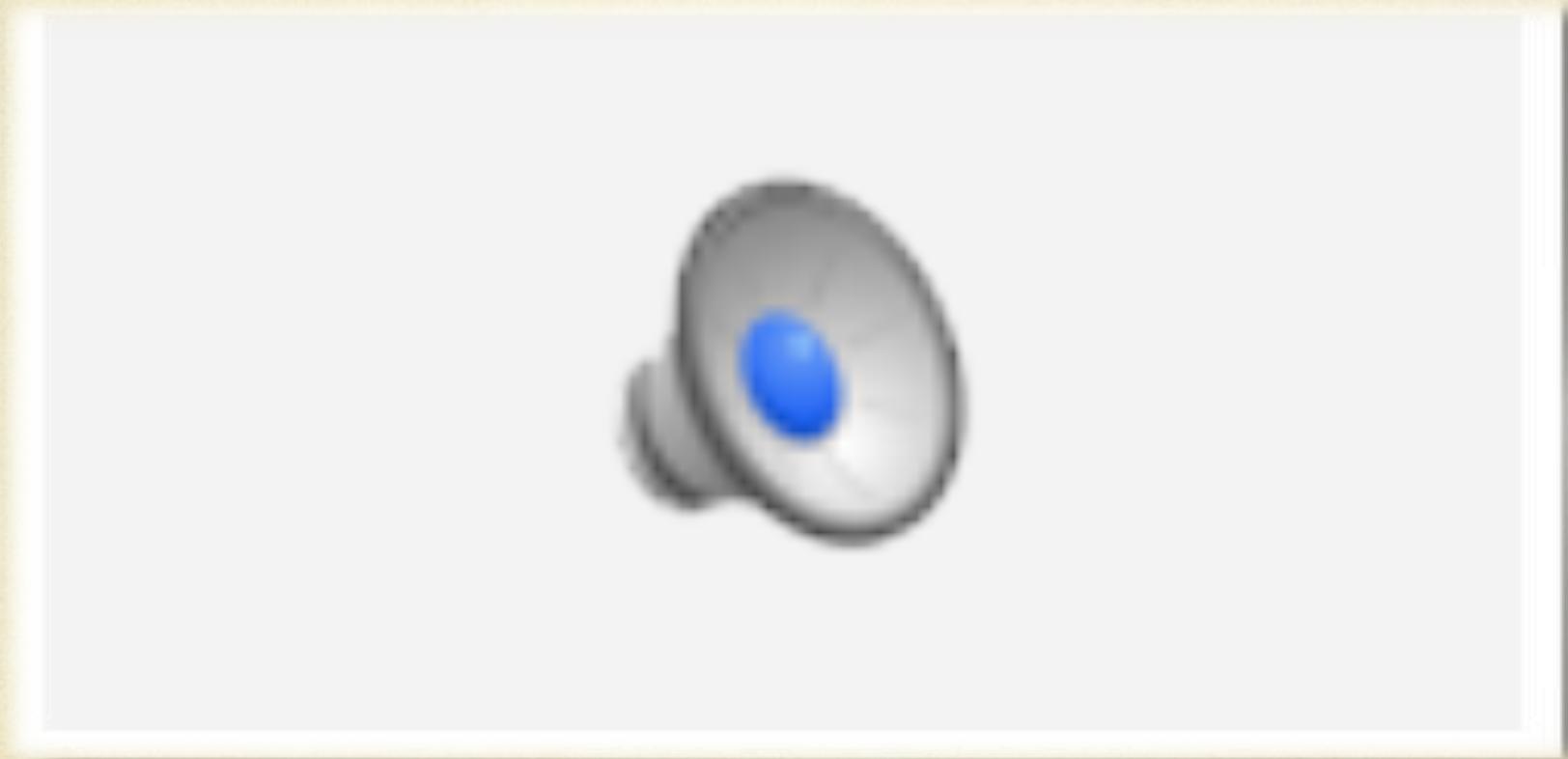


Data Type

- Quantitative Data
- Ordered Data
- Categorical Data
- Continuous / Discrete
- Time / Numerical
- Nominal / Classes

Visual: Data **encoding**  Visual symbols

Wealth and Health of Nations



Link: [https://www.gapminder.org/tools/#\\$state\\$time\\$value=2018;;&chart-type=bubbles](https://www.gapminder.org/tools/#$state$time$value=2018;;&chart-type=bubbles)



Data:

- Life expectancy
- Spending per person
- Total population
- Geographical region
- Time

Display:

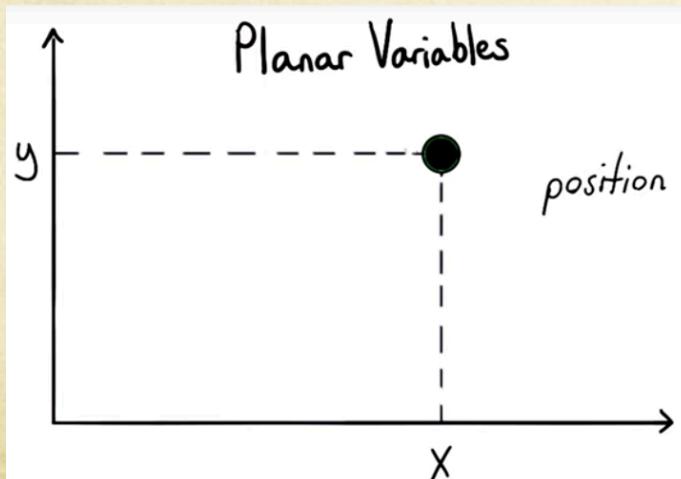
- Position y
- Position x
- Size
- Color
- Animation *

Variable Types

○ Planar Variable

1. accurate
2. sensitive

eg: position/length



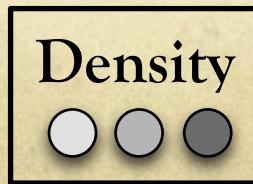
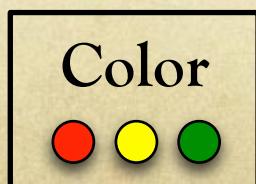
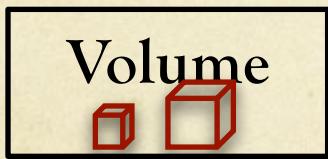
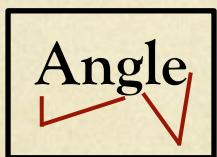
○ Retinal Variables

1. vague
2. less sensitive

Retinal Variables

Size	Color Hue
○ ○ ○ ○ ○	Blue Red Black Orange Blue
Orientation	Shape
/ / - -	□ × ☆ ○ △
Color Saturation	Texture
Blue Dark Blue Black	Horizontal stripes Diagonal stripes Vertical stripes Dots Vertical lines

More Accurate



Effectiveness



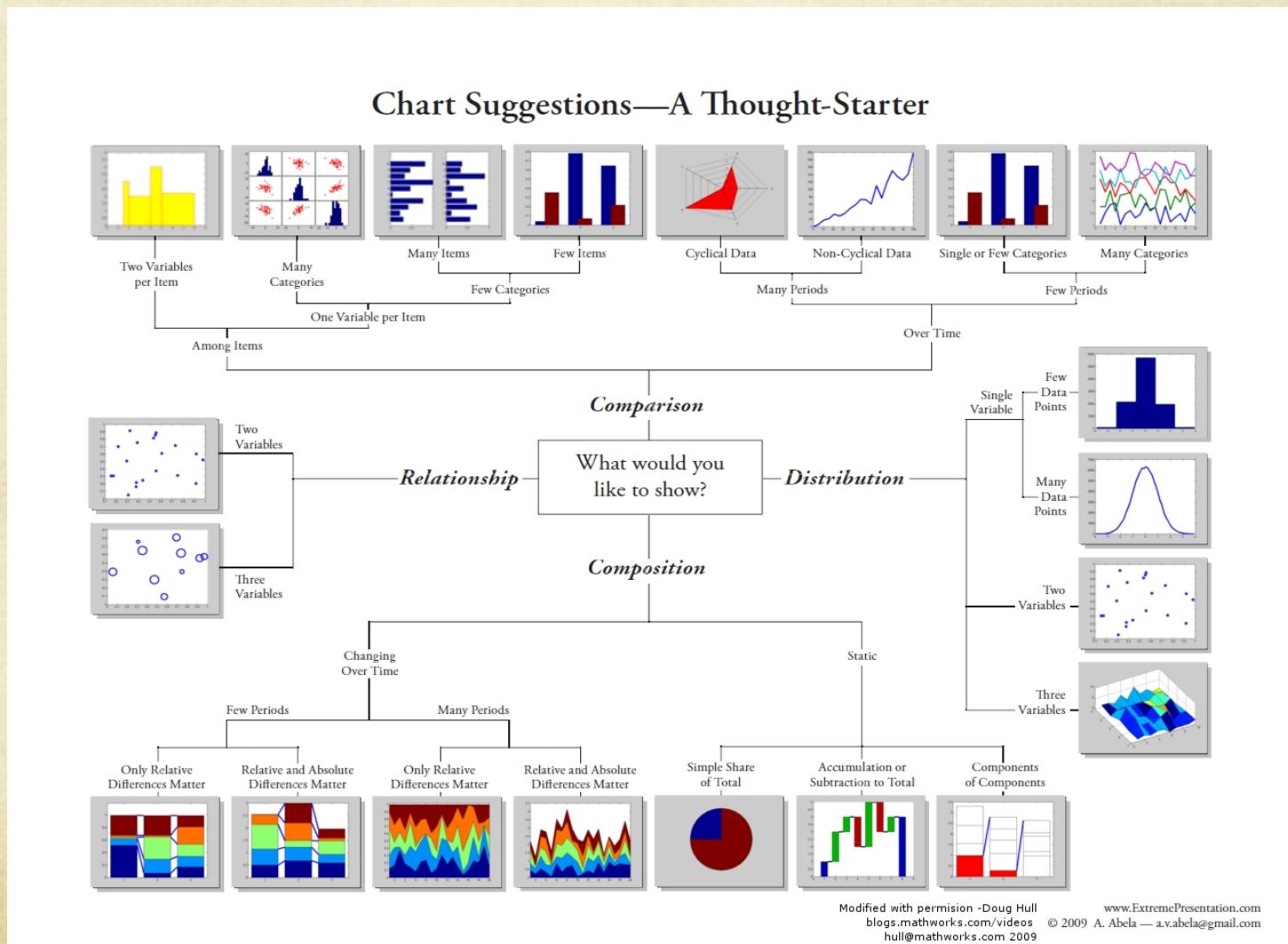
Less Accurate

Visual encoding effectiveness

Visual encoding by data type

	Quantitative	Ordinal	Nominal
More Accurate ↑	Position Length Angle Slope Area Density Saturation Hue Shape	Position Density Saturation Hue Length Angle Slope Area Shape	Position Hue Density Saturation Shape Length Angle Slope Area
	• • — ∠ / / • • • • • • • • • • ▲ □ • •	• • • • • • • • • • • — ∠ / / • • • •	• • • • • • • • • • • • ▲ □ — ∠ / / • •
↓ Less Accurate			

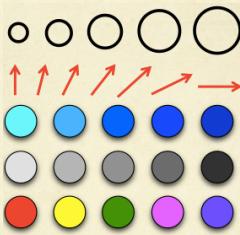
Graph Selection



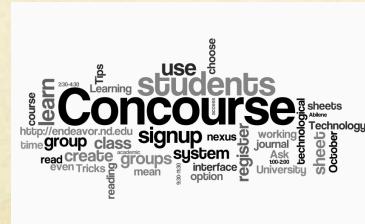
Making a Chart!

```
graph LR; Visual[Visual:] -- encoding --> Data[Data]; Data -- grammar --> VisualSymbols[Visual symbols]; VisualSymbols -- grammar --> Patterns[Patterns & Charts]
```

Table 1: Salt Concentration and Light Transmittance					
Salt Concentration (%)	Transmittance (%)T				
	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5
0	77.23	74.50	64.88	75.27	54.66
3	85.23	92.82	78.91	60.71	57.96
6	88.39	100.05	73.66	66.51	64.54
9	80.71	100.05	68.29	64.91	52.96
12	82.66	117.18	71.01	56.91	46.95
15	72.55	115.40	65.72	66.03	55.38



Language: Data $\xrightarrow{\text{encoding}}$ Letters & Words $\xrightarrow{\text{grammar}}$ Sentences & Paragraphs



Link: [https://www.gapminder.org/tools/#\\$state\\$time\\$value=2018;;&chart-type=bubbles](https://www.gapminder.org/tools/#$state$time$value=2018;;&chart-type=bubbles)

Graphics Grammar

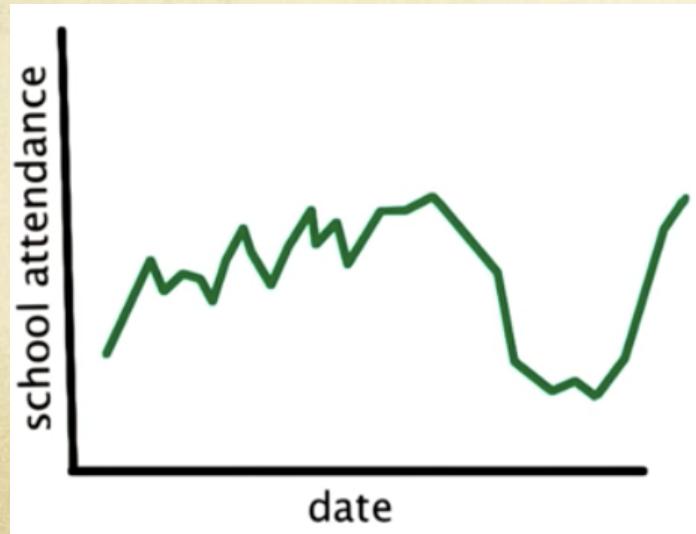
- Leland Wilkinson (developed in late 1990s)
- The Grammar of Graphics (<https://www.springer.com/series/3022>)
- Reference:
 1. A layered grammar of graphics
 2. Data Visualization: Rules for Encoding Values in Graph.

Graphics Grammar

- Separation of aesthetic data
- Definition of common graphic / graphic elements
- The composition of common elements

Separation of aesthetic data

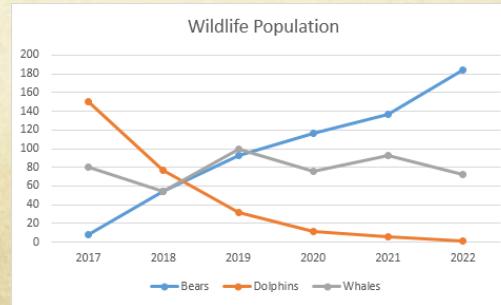
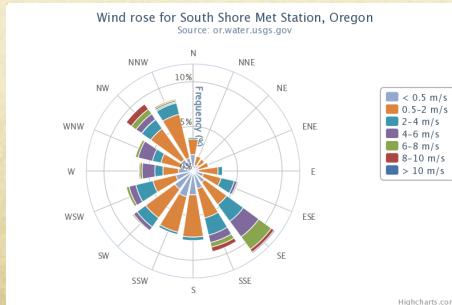
- Separate data with aesthetics
- Data Engineers → **Data Manipulation**
- Designers → **Visual encodings**
- Display multiple visual representations of data sets



date	attendance
1-12-14	602
1-13-14	598
1-14-14	576
.	.
.	.
.	.
2-18-14	253
2-20-14	201

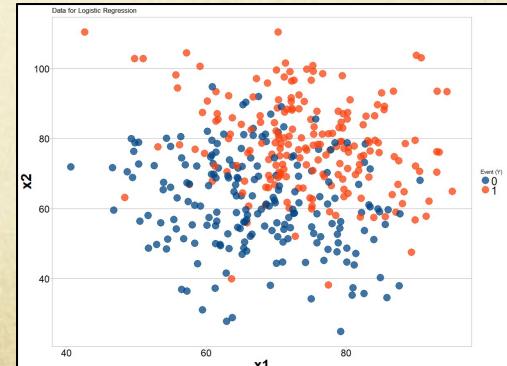
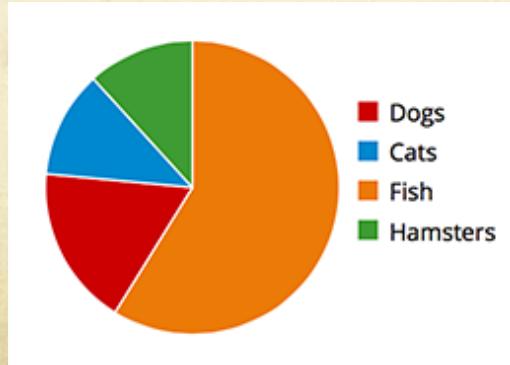
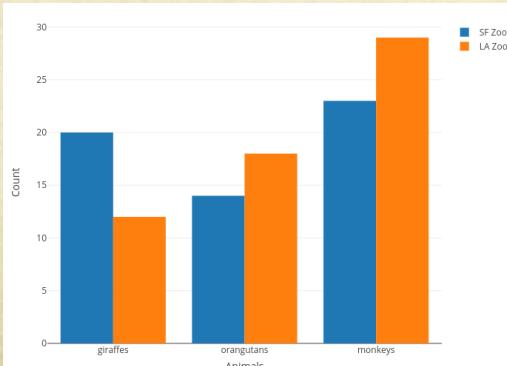
Common elements

- Coordinate system (Cartesian and radial/polar coordinate systems)
- Ruler (Linear, Logarithmic, etc.)
- Text annotation
- Shape (Lines, circles, etc.)
- Data type (classification, continuous, etc.)



Composition elements

- Classification data + Continuous data * Cartesian coordinate system = **Bar Chart**
- Category Data + Continuous Data * Polar Coordinate System = **Pie Chart**
- Continuous data + Continuous data * Cartesian coordinate system = **Scatter Plot**

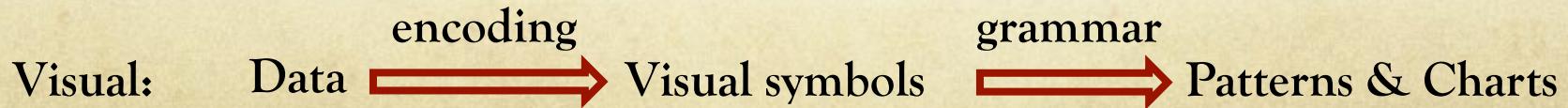


Practice

- World-Cup Data
- Book-Cross Data

Summary

- Visual Encoding Steps:
 - 1. Collect Data: Non-structured → Structured
 - 2. Decide Visual Symbols
 - 1) Data type
 - 2) Select a Graph
 - 3. Making a Chart (consider the Visual Grammar)



Thank
you !!