



澳門大學  
UNIVERSIDADE DE MACAU  
UNIVERSITY OF MACAU

# Visual Perception & Design

## CISC7204: DATA SCIENCE & VISUALIZATION

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Natural Language Processing & Portuguese –  
Chinese Machine Translation Laboratory  
自然語言處理與中葡機器翻譯實驗室

# Content

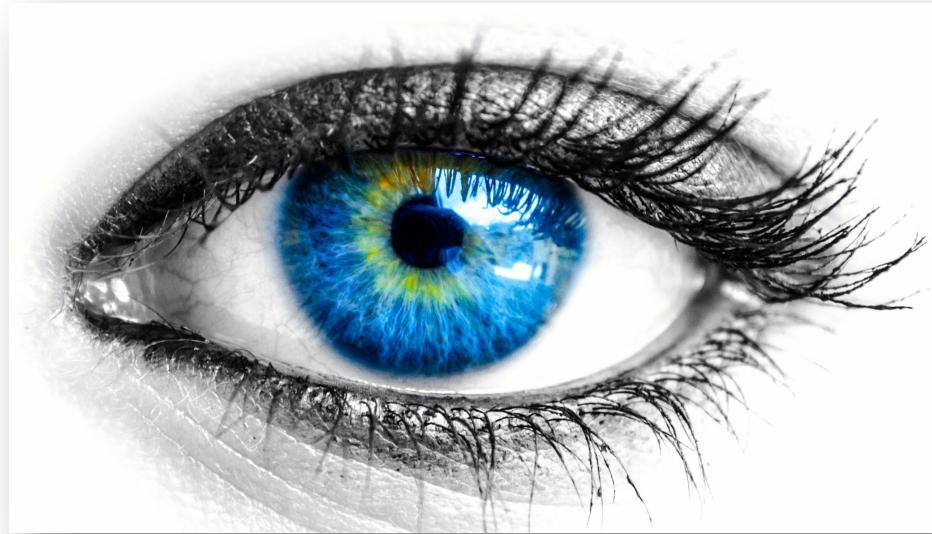
- Visual Perception
- Visual Principles
- Pre-attentive Properties
- Visual Basis
- Thinking Systems

# Goals of Data Visualization

Visualization should:

- *Make* large datasets *coherent*
  - *Present huge amounts of information compactly*
- *Present* information from *various viewpoints*
- *Present* information at *several levels of detail*
  - *From overviews to fine structure*
- *Support* visual *comparisons*
- *Tell stories* about the data

# Visual Perception



70%

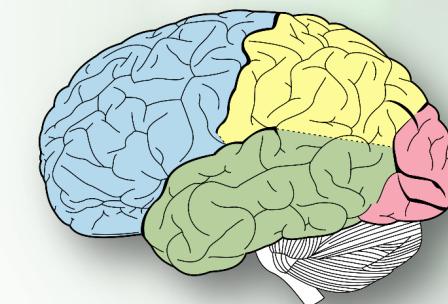
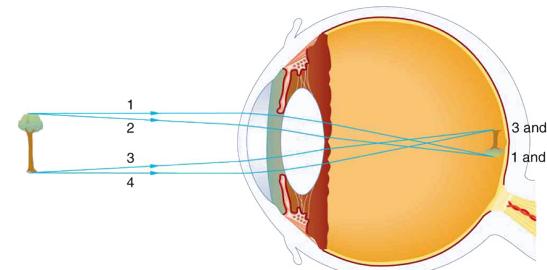
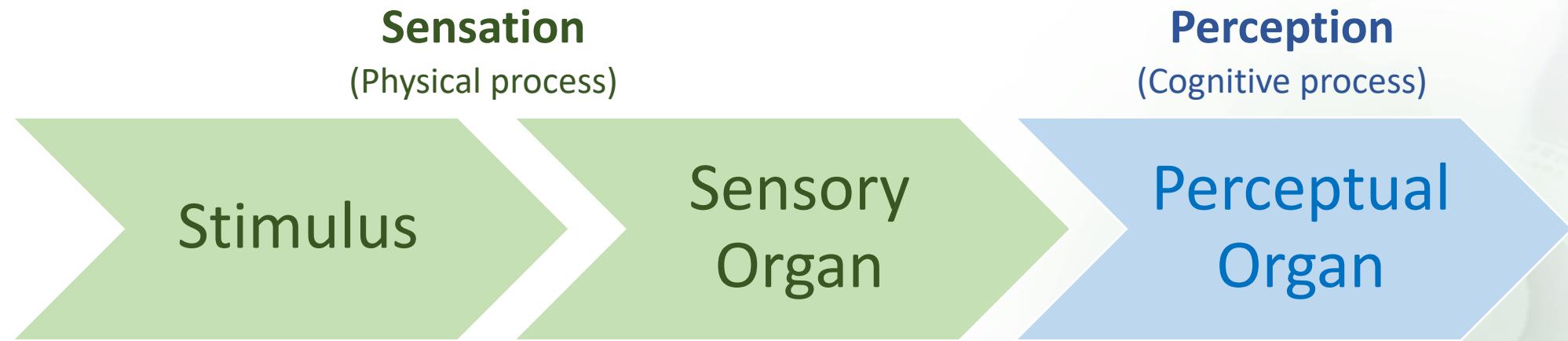
*70% of body's **sense receptors** reside in our eyes*

*40% of the **cerebral cortex** is involved in processing **visual information***



30%

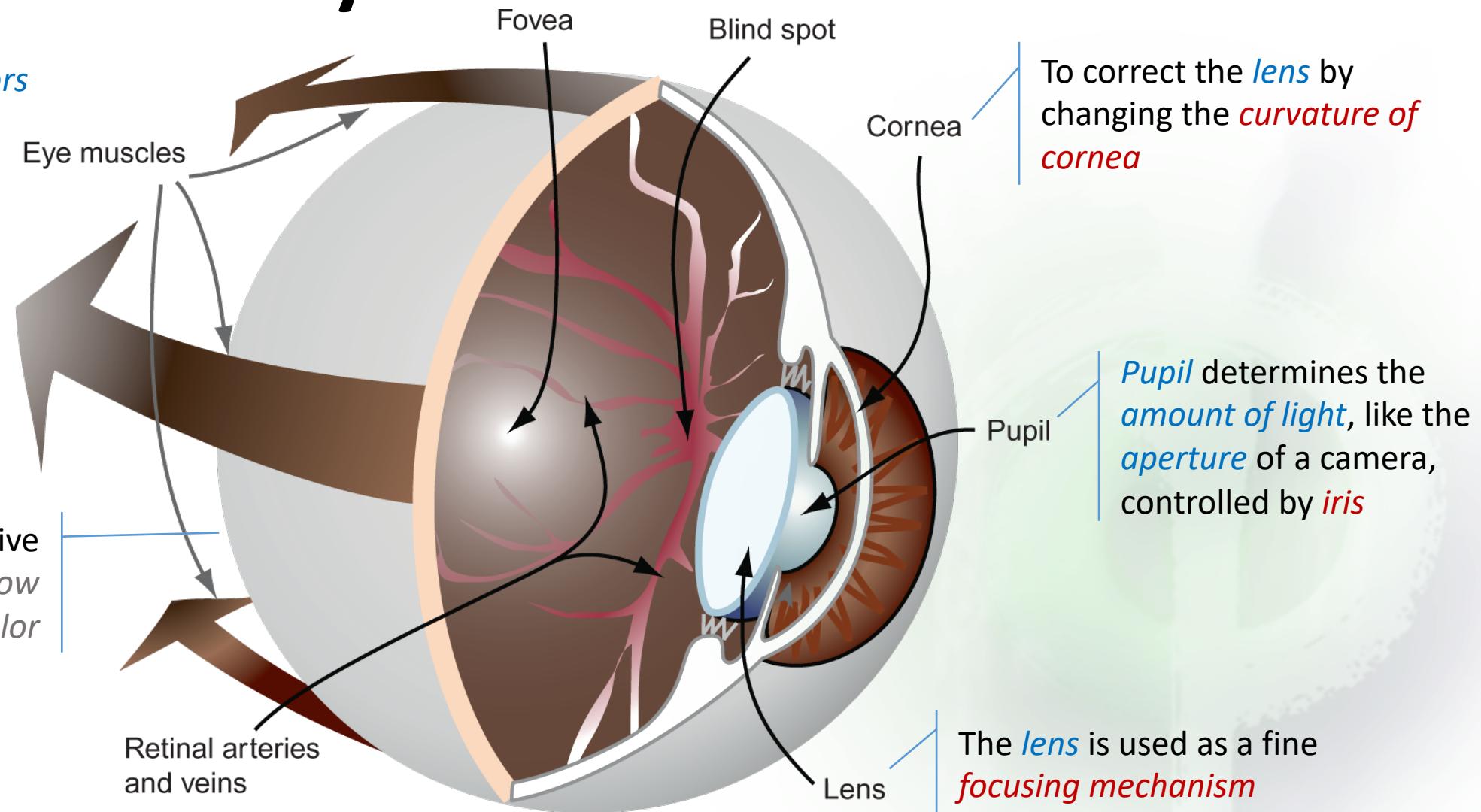
# Mechanics of Sight



# The Eye Anatomy

*Signals* from the *receptors* leave through the *optic nerve* to the *brain*

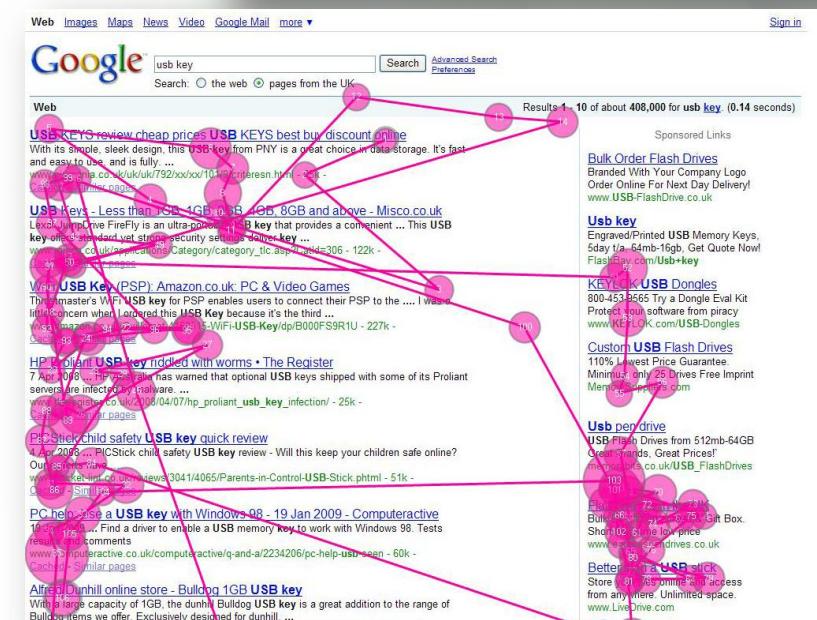
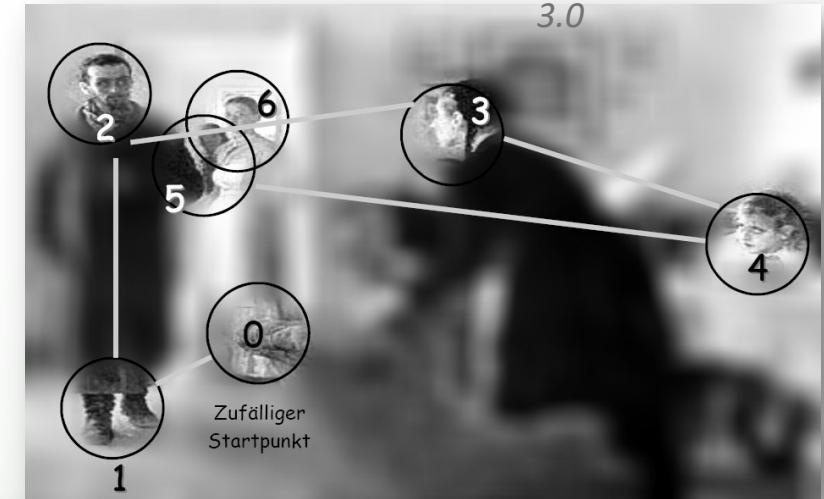
*Retina* is the photosensitive “*detector*”, *rods* for *low light level*, & *cones* for *color*



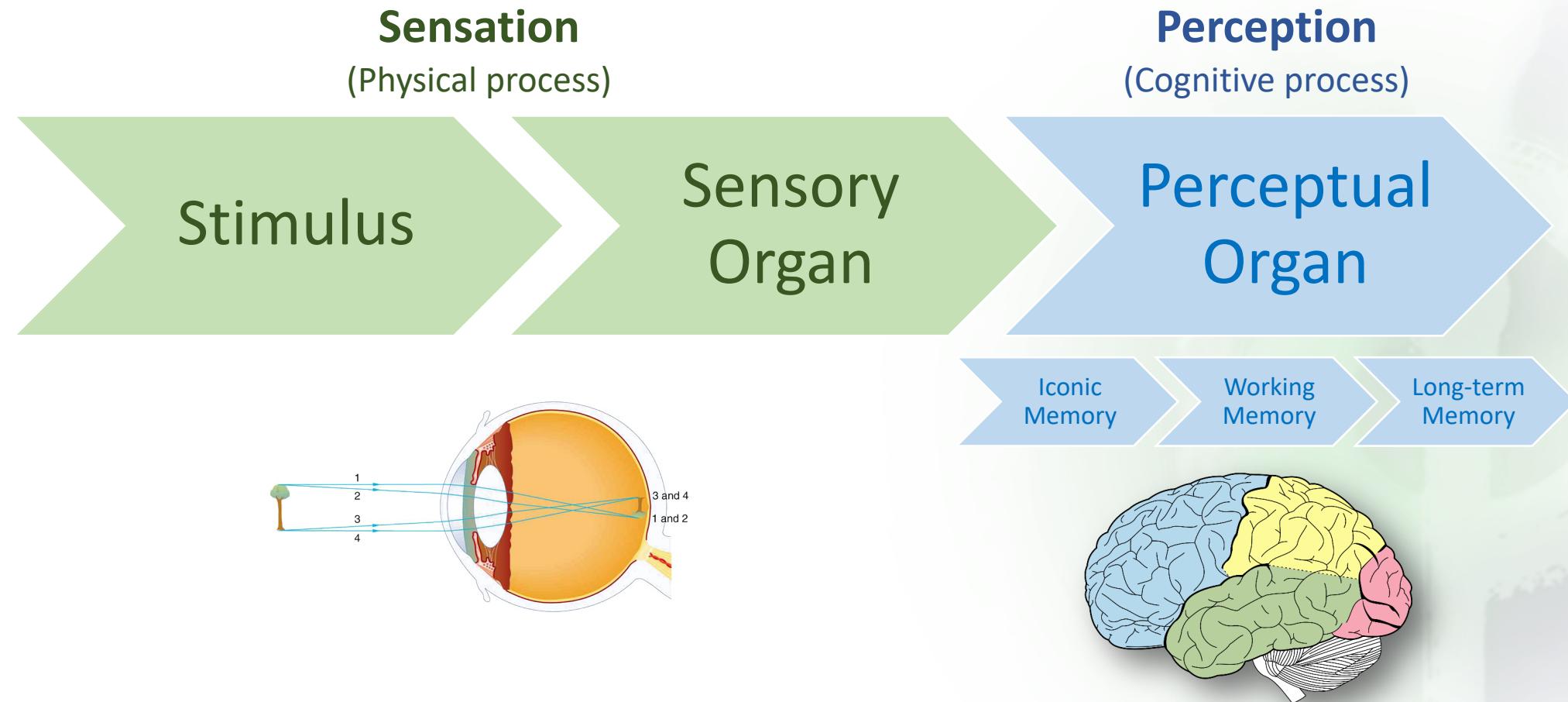
# Eye Movement

Since *fovea* can focus on a *limited area* at a time the process of *seeing is not smooth* → the sudden change is called *saccade* (saccadic eye movement)

- Fixation on a *particular spot up to 0.5s* (average 0.25s)
- Meanwhile non-foveal parts of the retina *survey the full field of vision* to *choose next spot*
- *Jumping* to the next point of fixation – *20~40ms*



# The Brain



# Iconic Memory

## *Sensory Memory w/ Visual*

- *Information remains* in the iconic memory for *less than a second*
- Processing in iconic memory is **unconscious** → *pre-attentive processing*
  - Process of *recognition*, detects *visual attributes* such as *color, size, orientation, location (pre-attentive attributes)*

Iconic Memory is a form of sensory memory with ultra-short-term memory

**ICONIC MEMORY** is a form of sensory memory with **ultra-short-term memory**

# Working Memory

- Processing in working memory is **conscious** → *attentive processing*
- *Data passed* from *iconic* to *working* memory where they are combined and stored as **visual chunks**
- Characteristics
  - *Temporary*
    - If not rehearsed, the *chunks stays in working memory* for **only few seconds**
    - *Limited* storage capacity: **3-4 chunks**
      - A reader can therefore *hold only a few chunks of information* in her head → a legend of a graph with **10 shapes** or **colors** forces the reader to constantly refer back to the legend

ICONIC MEMORY is a form of sensory memory with **ultra-short-term memory**

# Long-Term Memory

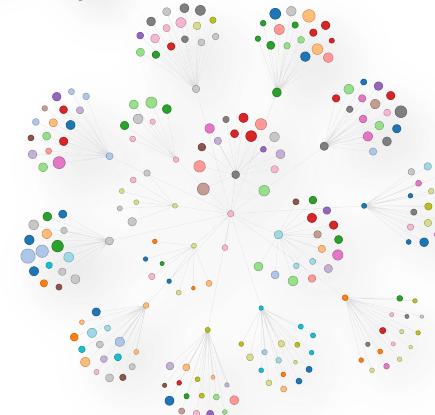
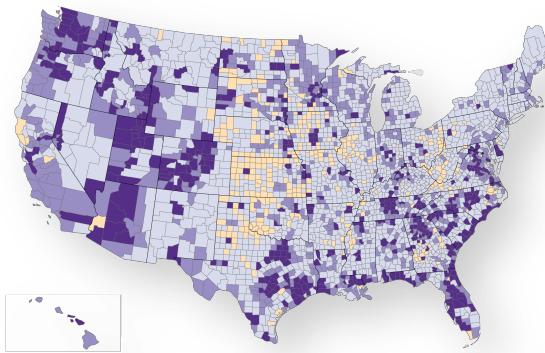
- When it is decided (**consciously** or **unconsciously**) that a *chunk needs to be stored* it is *moved* (by rehearsal) *to long-term memory*
- Long-term memory has the ability to *recognize images and detect meaningful patterns*

# Visual Principles

*Types of Visualizations & Graphs*

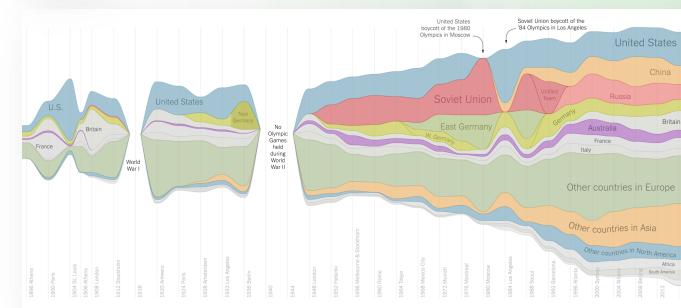
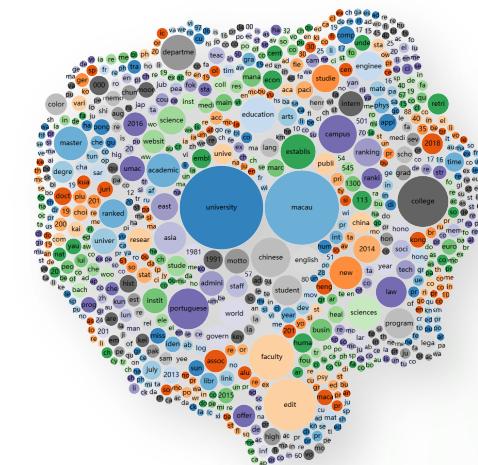
# Type of Data Visualizations

# Area or Geospatial



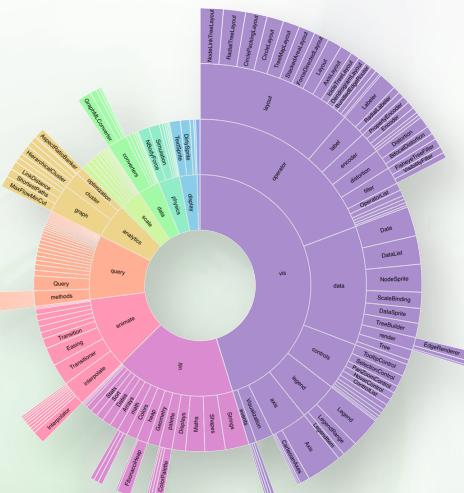
# Network

# Multidimensional



# Temporal

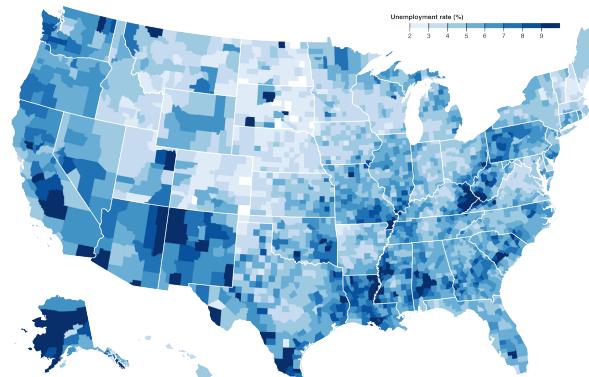
# Hierarchical



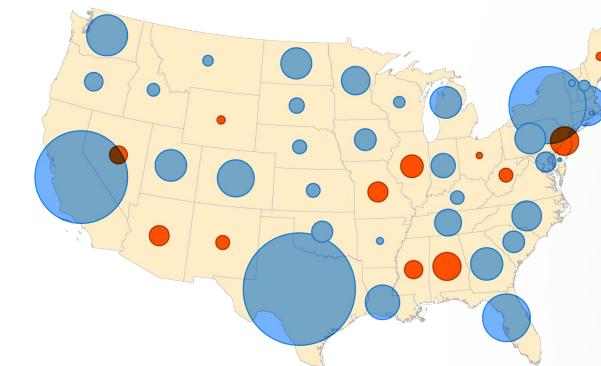
# Type of Data Visualizations

## *Area or Geospatial*

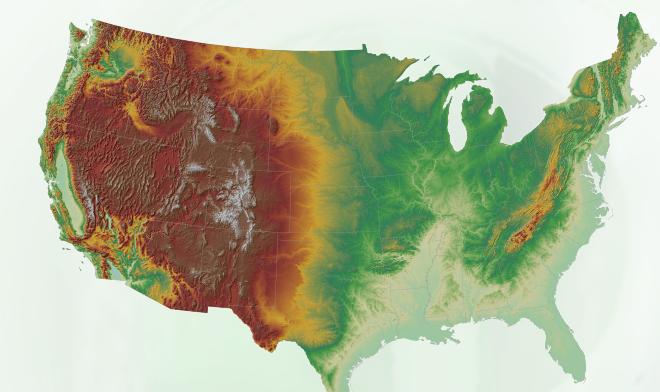
Area types of data visualization are usually *geospatial*, meaning that they relate to the *relative position* of things on the *earth's surface*



*Choropleth*



*Proportional Symbol Map*

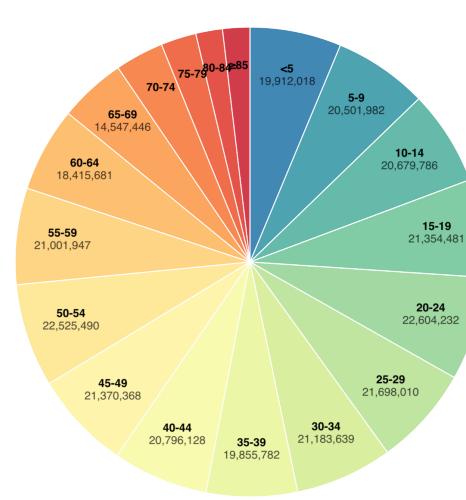


*Topographical Map*

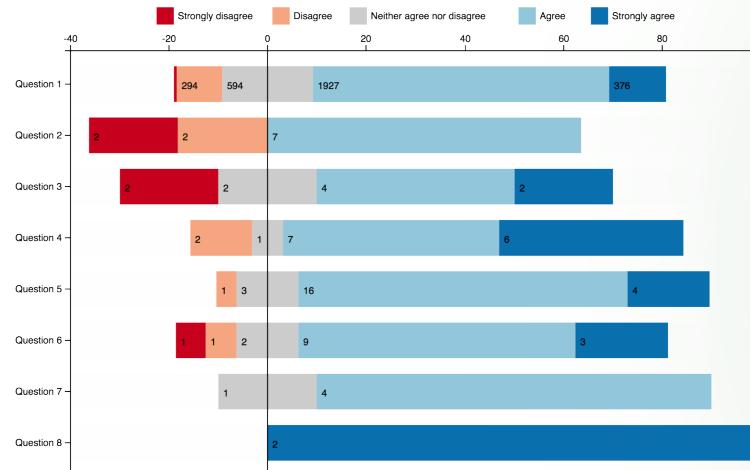
# Type of Data Visualizations

## *Multidimensional*

*Multidimensional* data elements are those with *two or more dimensions*, and are home to many of the most common types of data visualization



# *Pie Chart*



## *Stacked Bar Chart*

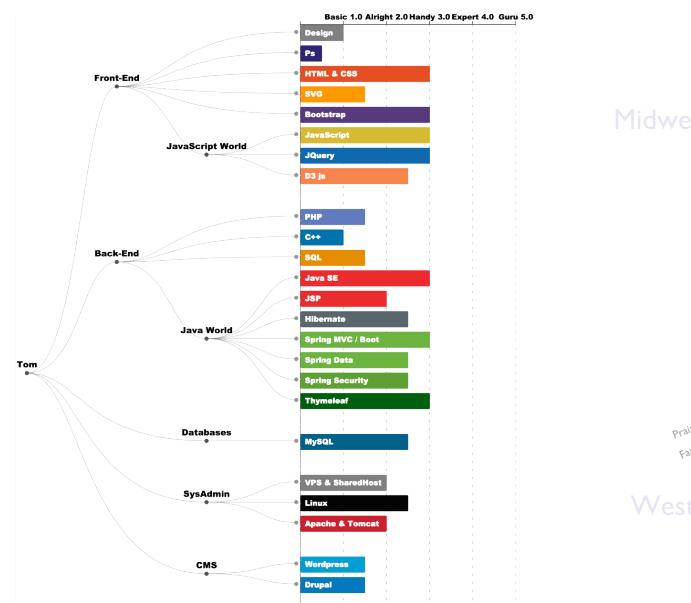


# *Bubble Chart*

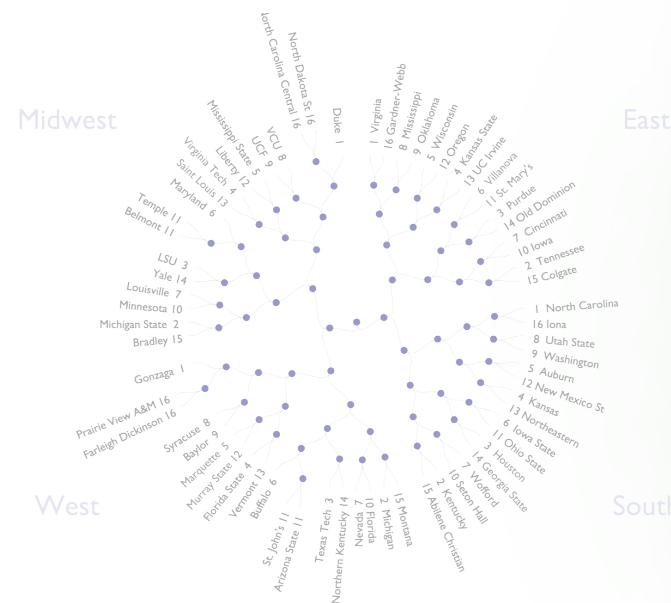
# Type of Data Visualizations

## *Hierarchical*

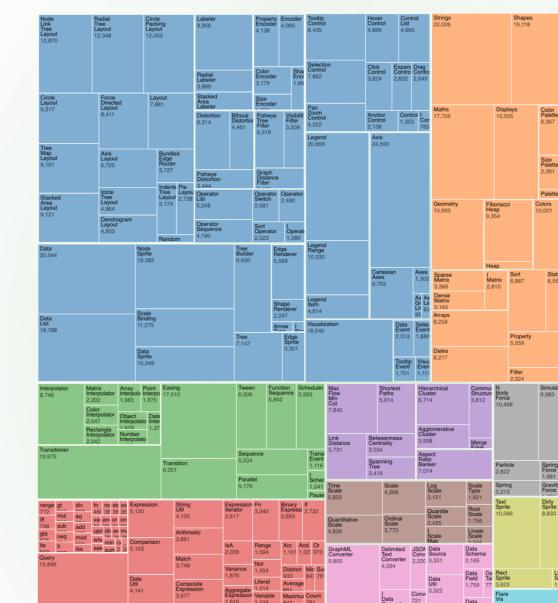
*Hierarchical* data sets are *orderings of groups* in which *larger groups* encompass sets of *smaller groups*



# Dendrogram



# *Circular Tree*

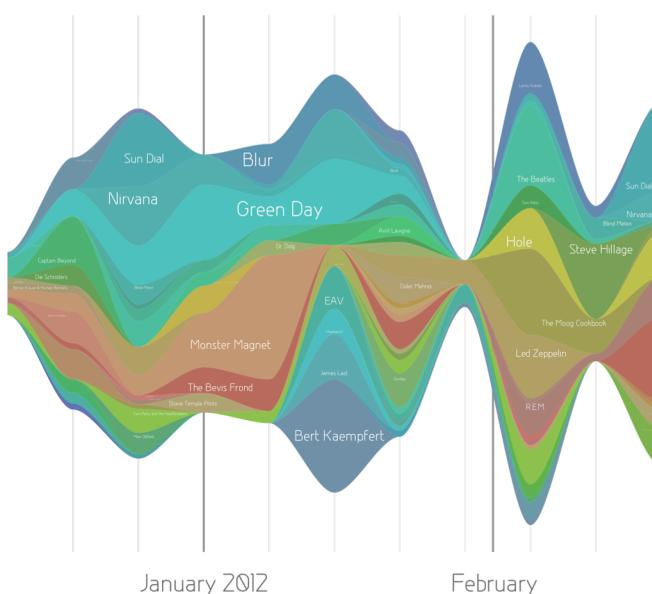


# *Tree Map*

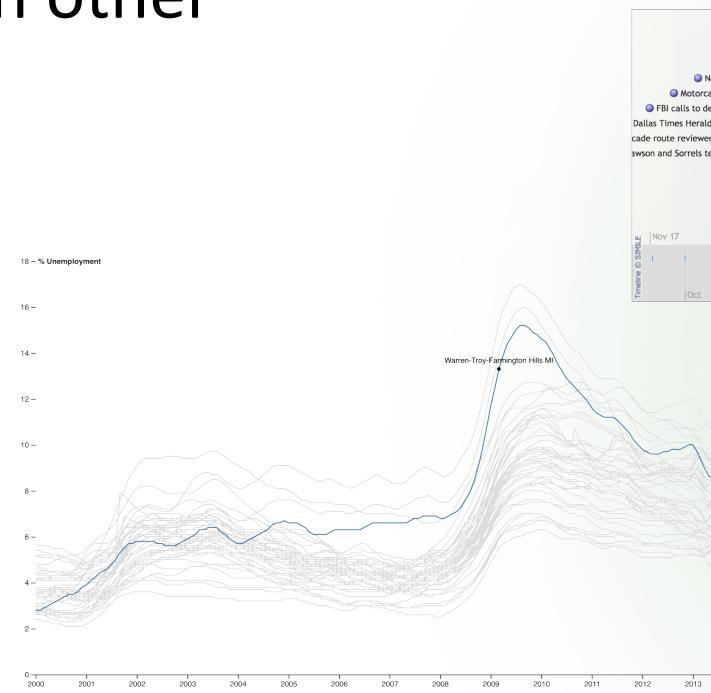
# Type of Data Visualizations

## Temporal

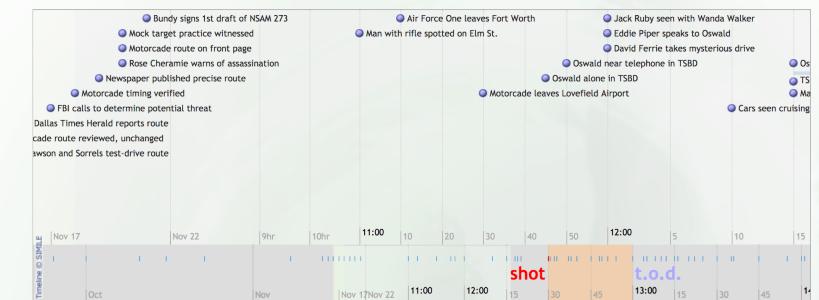
*Temporal* visualizations are similar to *one-dimensional linear visualizations*, but differ because they have a *start* and *finish time* and items that may overlap each other



Steam Graph



Multi-Line Chart



Timelines

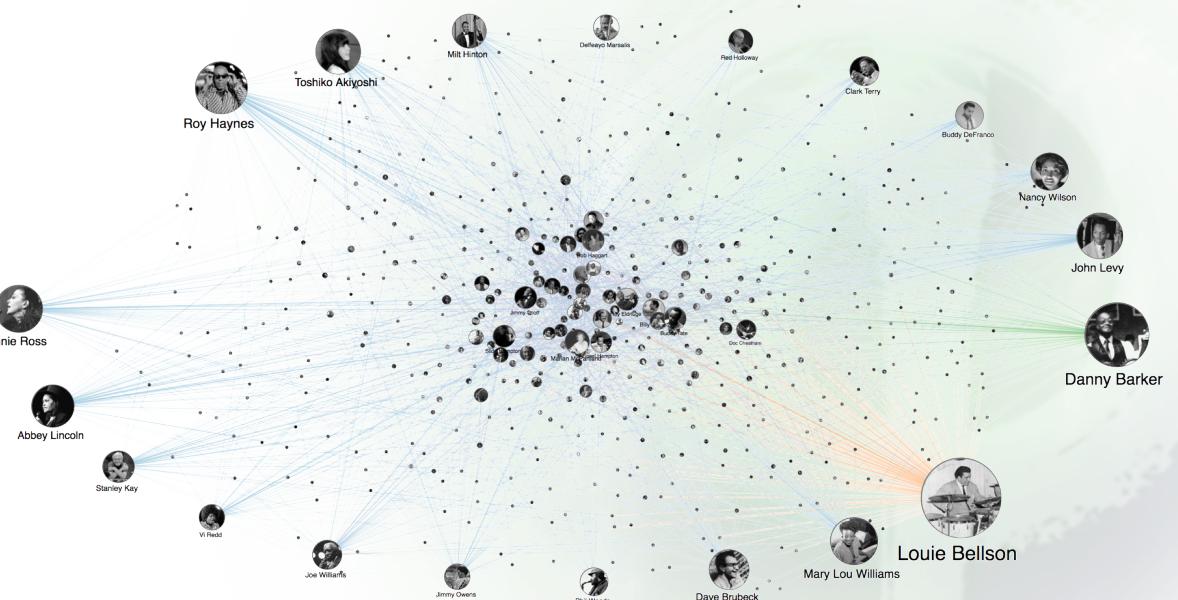
# Type of Data Visualizations

## Network

*Network data* visualizations show *how data sets are related to one another* within a network



Subway Map



Link Network

# Types of Graphs



Arc Diagram



Area Graph



Bar Chart



Box & Whisker Plot



Brainstorm



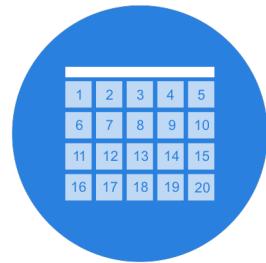
Bubble Chart



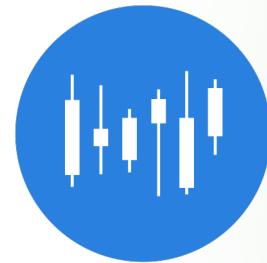
Bubble Map



Bullet Graph



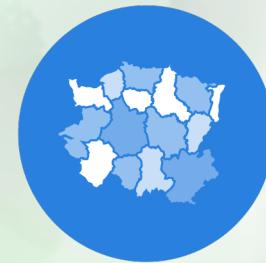
Calendar



Candlestick Chart



Chord Diagram



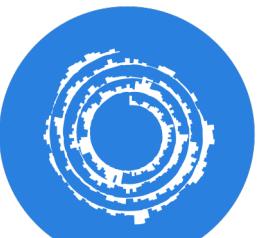
Choropleth Map

*The Data Visualization Catalogue@2019*

# Types of Graphs



Circle Packing



Spiral Plot



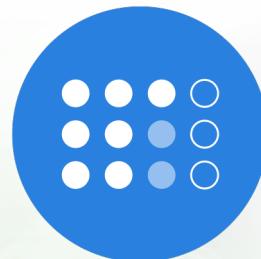
Connection Map



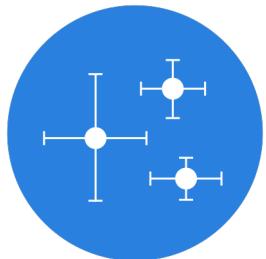
Density Plot



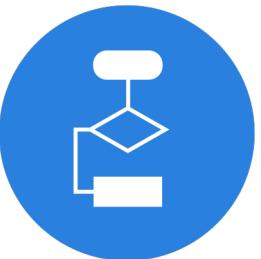
Dot Map



Dot Matrix Chart



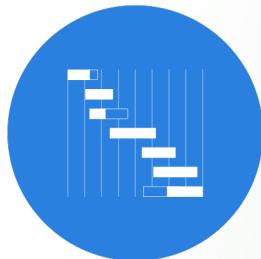
Error Bars



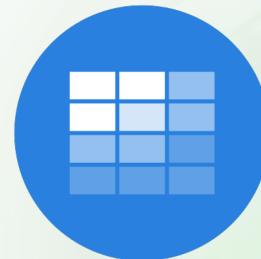
Flow Chart



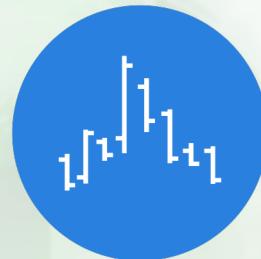
Flow Map



Gantt Chart



Heatmap



Open-high-low-close Chart



Histogram

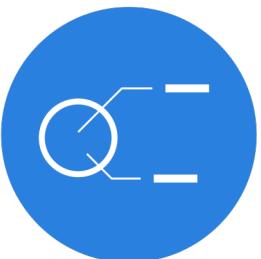
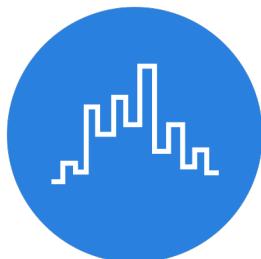


Illustration Diagram



Kagi Chart



Line Graph

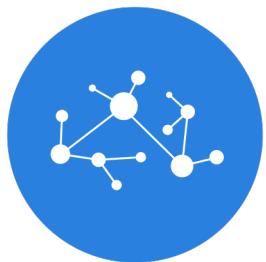


Marimekko Chart

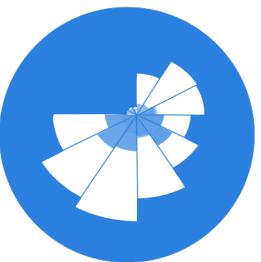


Multi-set Bar Chart

# Types of Graphs



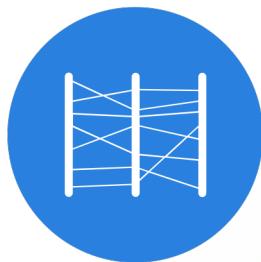
Network Diagram



Nightingale Rose Chart



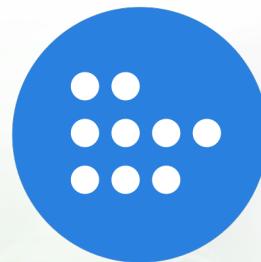
Dot Map



Parallel Coordinates Plot



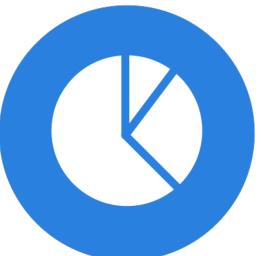
Parallel Sets



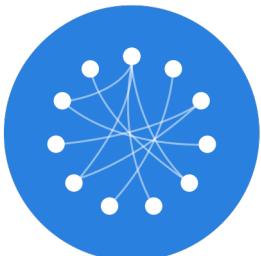
Pictogram Chart



Point & Figure Chart



Pie Chart



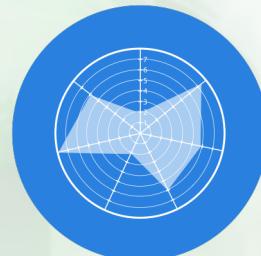
Non-ribbon Chord Diagram



Population Pyramid



Proportional Area Chart



Radar Chart



Radial Bar Chart



Radial Column Chart



Sankey Diagram



Scatterplot

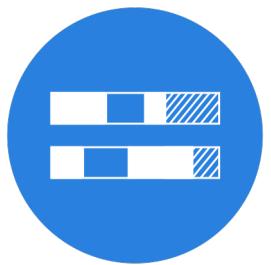


Span Chart

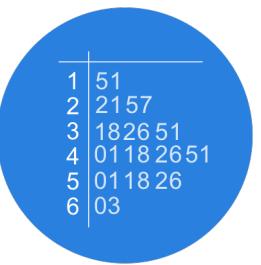


Stacked Area Graph

# Types of Graphs



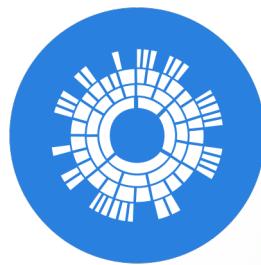
Stacked Bar Graph



Stem & Leaf Plot



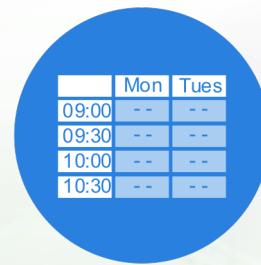
Stream Graph



Sunburst Diagram



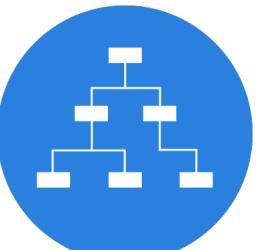
Tally Chart



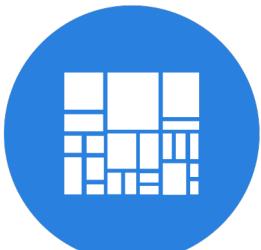
Timetable



Timeline



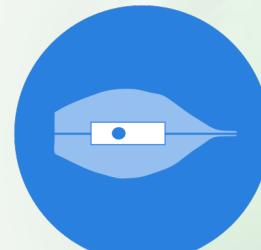
Tree Diagram



Treemap



Venn Diagram



Violin Plot



Word Cloud