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CHANGE THE WORLD FROM HERE

Design Principles

How to Design Visualizations

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Designing Visualizations

- **What** data are you visualizing?
- **Why** are you visualizing that data?
- **Why** would others use your visualization?
- **How** will you encode the data?
- **How** will you know you succeeded?

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Type of Data

- Multivariate Data
- Text Data
- Time Series Data
- Geospatial Data
- Hierarchical Data
- Network Data
- Numerical Data
- Categorical Data
- Structured Data
- Semi-Structured Data
- Unstructured Data

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Data Types

- Items
- Attributes
- Links
- Positions
- Grids

Data and Dataset Types

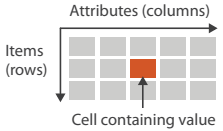
Tables	Networks & Trees	Fields	Geometry	Clusters, Sets, Lists
Items	Items (nodes)	Grids	Items	Items
Attributes	Links	Positions	Positions	
	Attributes	Attributes		

Dataset Availability

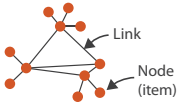
- Static
- Dynamic

Dataset Types

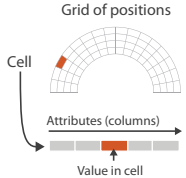
- Tables



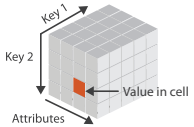
- Networks



- Fields (Continuous)



- *Multidimensional Table*



- *Trees*

- Geometry (Spatial)

Visualization Analysis and Design. Tamara Munzner, with illustrations by Eamonn Maguire. A K Peters Visualization Series, CRC Press, 2014.

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Visualization Purpose

- Convey complex information
- Capture attention and raise awareness
- Create something aesthetically pleasing
- Encourage exploration

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Visualization Task

- Quickly identify outliers
- Quickly identify groups/classes
- Quickly identify problems
- Explore data to gain insight
- Identify complex patterns

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Actions

Analyze

Consume

- *Discover*

- *Present*

- *Enjoy*

Produce

- *Annotate*

- *Record*

- *Derive*

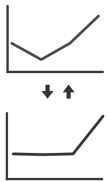
Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

- *Identify*

- *Compare*



- *Summarize*

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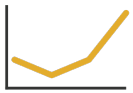
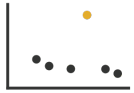
Targets

All Data

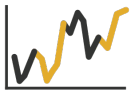
- Trends



- Outliers



- Features



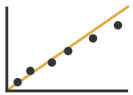
Attributes

- One
  - *Distribution*

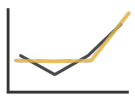
  - *Extremes*

- Many
  - *Dependency*

  - *Correlation*



  - *Similarity*



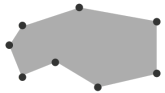
Network Data

- Topology

- *Paths*

Spatial Data

- Shape



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Encoding Data

- Map data to pre-attentive attributes
- Keep in mind perception
  - Which attributes are stronger?
  - How many distinct attributes can you use?
- Revisit if how encoding is perceived matches underlying data

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How?

Encode

- **Arrange**
  - Express
  - Separate
  - Order
  - Align
  - Use

- **Map**
  from categorical and ordered attributes

Manipulate

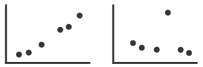
- **Change**

- **Select**

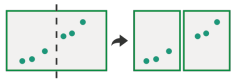
- **Navigate**

Facet

- **Juxtapose**



- **Partition**

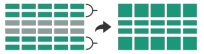


- **Superimpose**

Reduce

- **Filter**

- **Aggregate**



- **Embed**

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Encode › Map

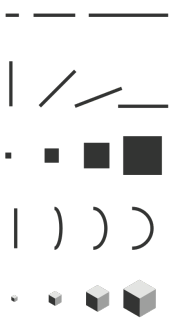
- **Color**
  - Color Encoding
    - Hue
    - Saturation
    - Luminance

  - Color Map
    - Categorical

    - Ordered
      - *Sequential*
      - *Diverging*

    - Bivariate

- **Size, Angle, Curvature, ...**
  - Length
  - Angle
  - Area
  - Curvature
  - Volume



- **Shape**

- **Motion**
  - Motion
    Direction, Rate, Frequency, ...

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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)

Most ▲ Effectiveness ▼ Least

Same (Color luminance, Color saturation)

Same (Curvature, Volume (3D size))

Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape

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Evaluation

- Does the visualization achieve your purpose?
- Can the users achieve their visualization task?
  - Quickly? Accurately?
- Can the design be improved?
  - Data Density? Data-Ink Ratio?
- Evaluate and iterate

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GUIDELINES

Information Visualization by Colin Ware

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Random Selection of Tips

- [G1.2] Important data should be represented by graphical elements that are **more visually distinct** than those representing less important information.
- [G1.6] Consider adopting novel design solutions only when the estimated payoff is substantially greater than the **cost of learning** to use them.

"Information Visualization: Perception for Design", by Colin Ware, 3rd Edition, 2013

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Random Selection of Tips

- [G3.1] Avoid using **grayscale** as a method for representing more than two to four values.
- [G4.1] Use more **saturated colors** when color coding small symbols, thin lines, or other small areas. Use less saturated colors for coding large areas.

"Information Visualization: Perception for Design", by Colin Ware, 3rd Edition, 2013

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Random Selection of Tips

- [G5.6] Use strong **pre-attentive** *cues* before weak ones where ease of search is critical.
- [G10.6] Consider providing a **small overview** map to support navigation through a large data space.

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