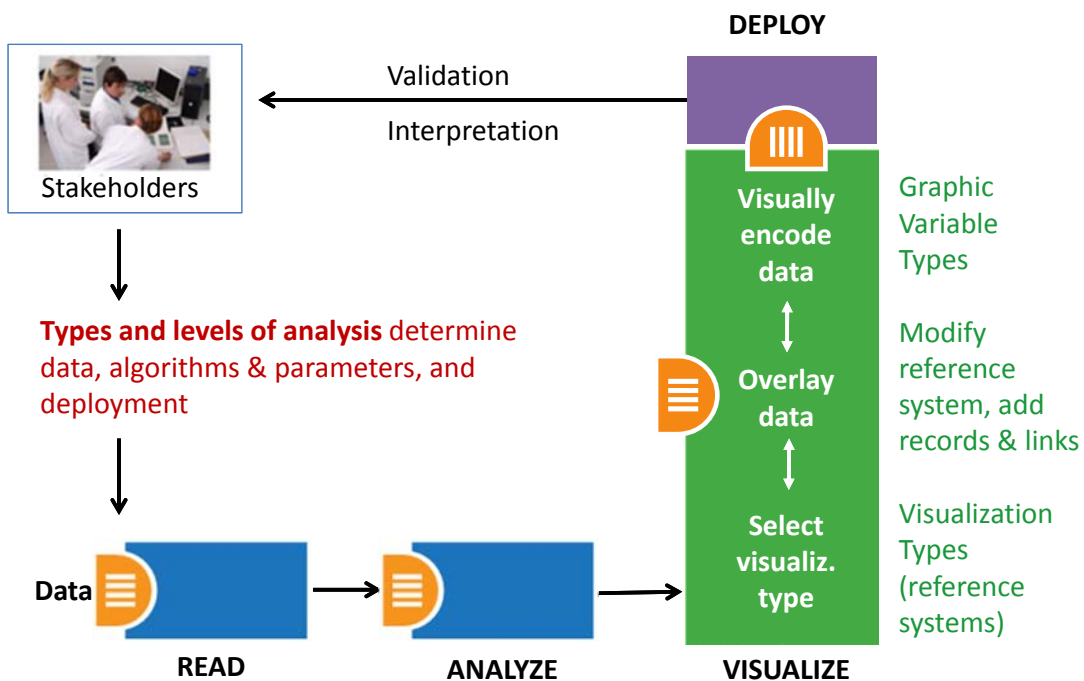


Needs-Driven Workflow Design



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Information Visualization MOOC

Unit 1: Visualization Framework & Workflow Design

Workflow Design

- Needs-Driven Workflow Design
- Visualization Types (Reference Systems)
- Data Overlays
- Graphic Variable Types
- Data Scale Types

Needs-Driven Visualization Design

We already discussed means to describe user needs:

- Analysis Types (When, Where, What, With Whom)
- Levels of Analysis (Micro ... Macro)

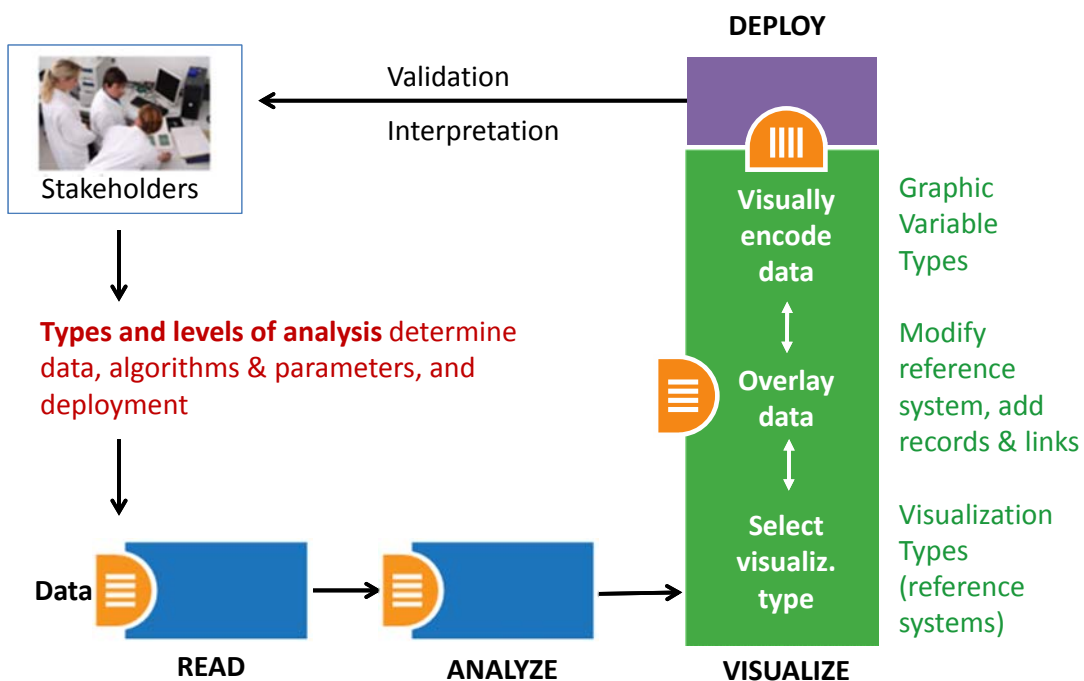
Here, we introduce:

- Visualization Types (reference systems)
- Data Overlays (modify reference system, add records & linkages)
- Graphic Variable Types (to visually encode data)

Required to **design** and **interpret** visualizations.

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Needs-Driven Workflow Design



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Visualization Types (Reference Systems)

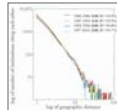
1. **Charts:** No reference system—e.g., Wordle.com, pie charts
2. **Tables:** Categorical axes that can be selected, reordered; cells can be color coded and might contain proportional symbols. Special kind of graph.
3. **Graphs:** Quantitative or qualitative (categorical) axes. Timelines, bar graphs, scatter plots.
4. **Geospatial maps:** Use latitude and longitude reference system. World or city maps.
5. **Network graphs:** Node position might depend on node attributes or node similarity. **Tree graphs:** hierarchies, taxonomies, genealogies. **Networks:** social networks, migration flows.

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How to Group and Classify Visualizations?

1. Charts:

2. Tables:

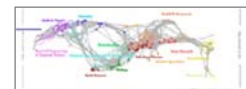
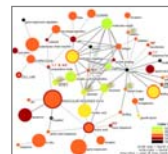
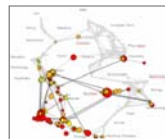
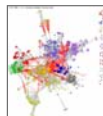
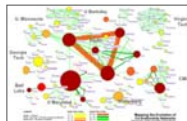


3. Graphs:

4. Geospatial maps:



5. Network graphs:



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Data Overlays

Given a reference system, also called base map (see Visualization Types), data record attributes can be used to

1. Modify base map—e.g., distort area sizes (cartogram) and/or to **visually encode** base map areas (color by #life expectancy)
2. Place data records and **visually encode** nodes.
3. Place data record linkages and **visually encode** links.

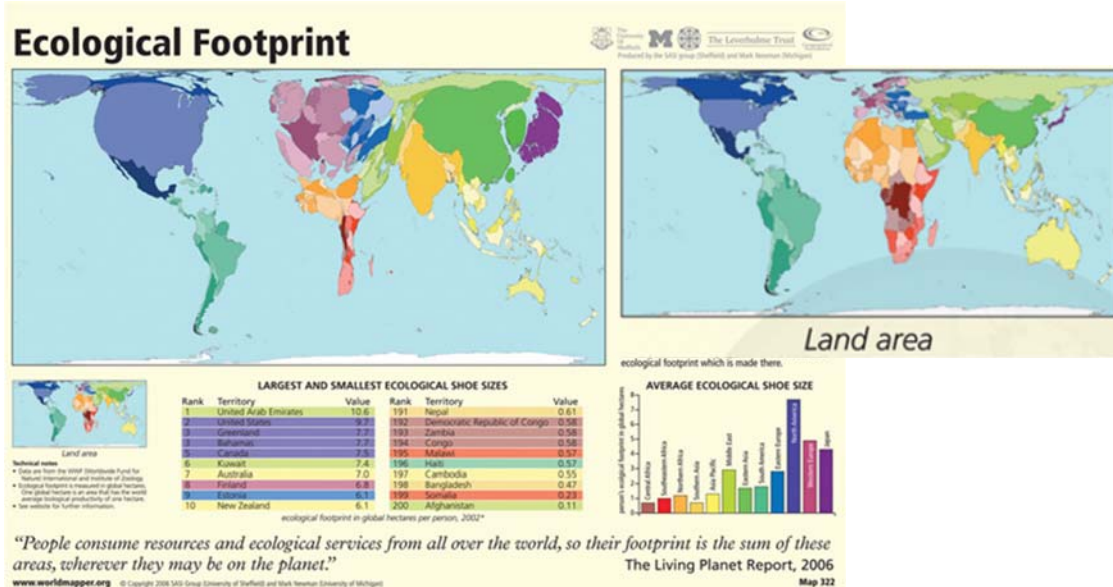
Aggregations such as cluster boundaries or network backbones are encoded using steps 1-3 at different (semantic) zoom levels.

In addition, there is commonly a title, labels, legend, explanatory text, and author info.

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Data Overlays – Step 1 Example

Given a map of the world, distort area sizes (cartogram)



Ecological Footprint, http://scimaps.org/maps/map/ecological_footprint_42,
<http://worldmapper.org>

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Data Overlays – Step 1 Example

Given a map of the world, **visually encode** base map areas:

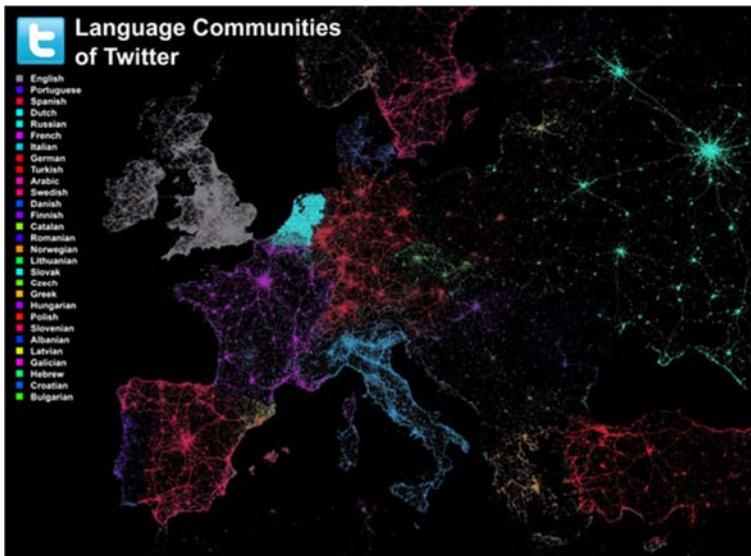


The Millennium Development Goals Map, <http://un.org/millenniumgoals>
http://scimaps.org/maps/map/the_millennium_devel_90/

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Data Overlays – Step 2 Example

Given a map of Europe, place data records & **visually encode** them.



Language Communities of Twitter,
http://scimaps.org/maps/map/language_communities_146/

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Data Overlays – Step 3 Example




Given a world map, place data links & **visually encode** them.



Scientific Collaborations between World Cities,
http://scimaps.org/maps/map/stream_of_scientific_128/

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Visualization Types vs. Data Overlays

Visualization Type	Chart	Table	Graph	Geospatial Map	Network Graph
Modify / visually encode base map.					
Place and visually encode records/nodes.					
Place and visually encode links.					

Plus, add a title, labels, legend, explanatory text, and author info.

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Visualization Types vs. Data Overlays

Visualization Type	Chart	Table	Graph	Geospatial Map	Network Graph
Modify / visually encode base map.					
Place and visually encode records/nodes.					
Place and visually encode links.					

Plus, add a title, labels, legend, explanatory text, and author info.

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Graphic Variable Types

Position: x, y; possibly z

Form:

- Size
- Shape
- Orientation/Rotation

Color:

- Value (Lightness) 

- Hue (Tint) 

- Saturation (Intensity) 

Texture:

- Pattern, Rotation, Coarseness, Size, Density Gradient

Optics:

- Crispness, Transparency, Shading

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Graphic Variable Types

What data attributes should be encoded using which graphic variable type?

Sample data table:

Name	Age	US ZIP	Profession
Eva	30	47401	Teacher
Bruce	46	47405	Engineer

Use **data scale types** to guide encoding.

Position: x, y; possibly z

Form:

- Size
- Shape
- Orientation/Rotation

Color:

- Value (Lightness)
- Hue (Tint)
- Saturation (Intensity)

Texture:

- Pattern, Rotation, Coarseness, Size, Density Gradient

Optics:

- Crispness, Transparency, Shading

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Data Scale Types

Categorical (nominal): A categorical scale, also called nominal or category scale, is qualitative. Categories are assumed to be non-overlapping.

Ordinal: An ordinal scale, also called sequence or ordered, is a qualitative. It rank-orders values representing categories based on some intrinsic ranking but not at measurable intervals.

Interval: An interval scale, also called value scale, is a quantitative numerical scale of measurement where the distance between any two adjacent values (or intervals) is equal but the zero point is arbitrary.

Ratio: A ratio scale, also called proportional scale, is a quantitative numerical scale. It represents values organized as an ordered sequence, with meaningful uniform spacing, and has a true zero point.

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Data Scale Types - Examples

Categorical: Words or numbers constituting the names and descriptions of people, places, things, or events.

Ordinal: Days of the week, degree of satisfaction and preference rating scores (e.g., using a Likert scale), or rankings such as low, medium, high.

Interval: Temperature in degrees or time in hours. Spatial variables such as latitude and longitude are interval.

Ratio: Physical measures such as weight, height, (reaction) time, or intensity of light; number of published papers, co-authors, citations.

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Data Scale Types - Examples

Categorical: Words or numbers constituting the names and descriptions of people, places, things, or events.

Ordinal: Days of the week, degree of satisfaction and preference rating scores (e.g., using a Likert scale), or rankings such as low, medium, high.

Interval: Temperature in degrees Celsius or Fahrenheit or time in hours. Spatial variables such as latitude and longitude.

Ratio: Physical measures such as weight, height, (reaction) time, or intensity of light; number of published papers, co-authors, citations. Kelvin absolute, thermodynamic temperature scale which uses as its null point absolute zero.

More Qualitative



More Quantitative

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Graphic Variable Types vs. Data Scale Types

Position: x, y; possibly z

Quantitative

Form:

- Size
- Shape
- Orientation (Rotation)

Quantitative

Qualitative

Qualitative

Color:

- Value (Lightness)
- Hue (Tint)
- Saturation (Intensity)



Quantitative



Qualitative



Quantitative

Texture:

- Pattern, Rotation, Coarseness, Size, Density Gradient

Quantitative

Optics:

- Crispness, Transparency, Shading

Qualitative

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Graphic Variable Types vs. Data Scale Types Example

Assume you have a dataset with Data Scale Types:

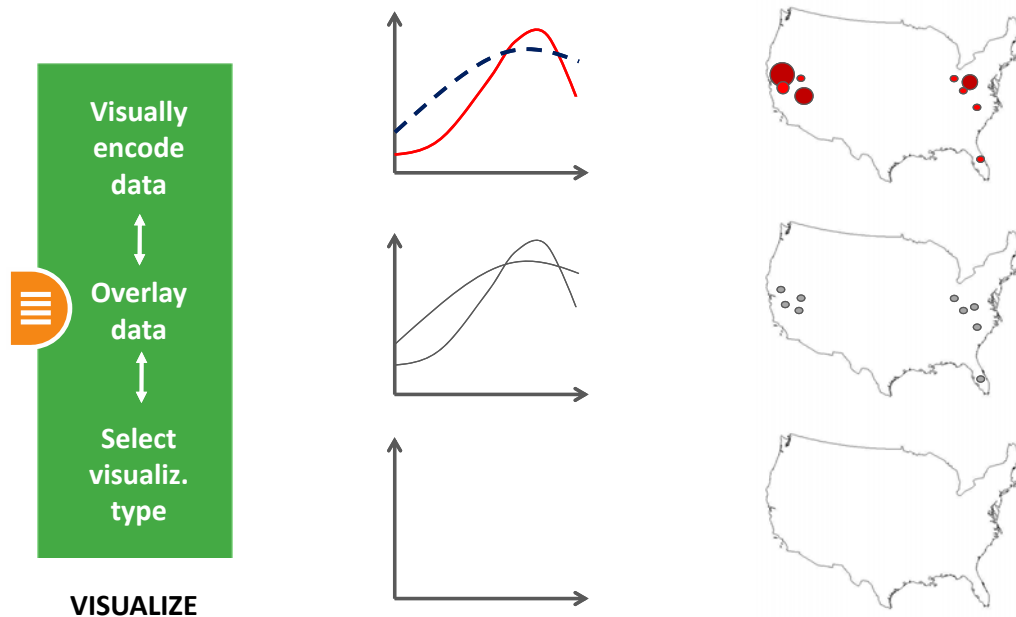
Name	Age	US ZIP	Profession
Eva	30	47401	Teacher
Bruce	46	47405	Engineer
<i>qualitative</i>	<i>quantitative</i>	<i>qualitative</i>	<i>qualitative</i>

And a tool that supports Graphic Variable Types: position, size (quantitative), and color hue, shape (qualitative).

	Name	Age	US Zip-> Latitude/Longitude	Profession
Position		<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Size		<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Color hue	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Shape	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
	<i>qualitative</i>	<i>quantitative</i>	<i>quantitative</i>	<i>qualitative</i>

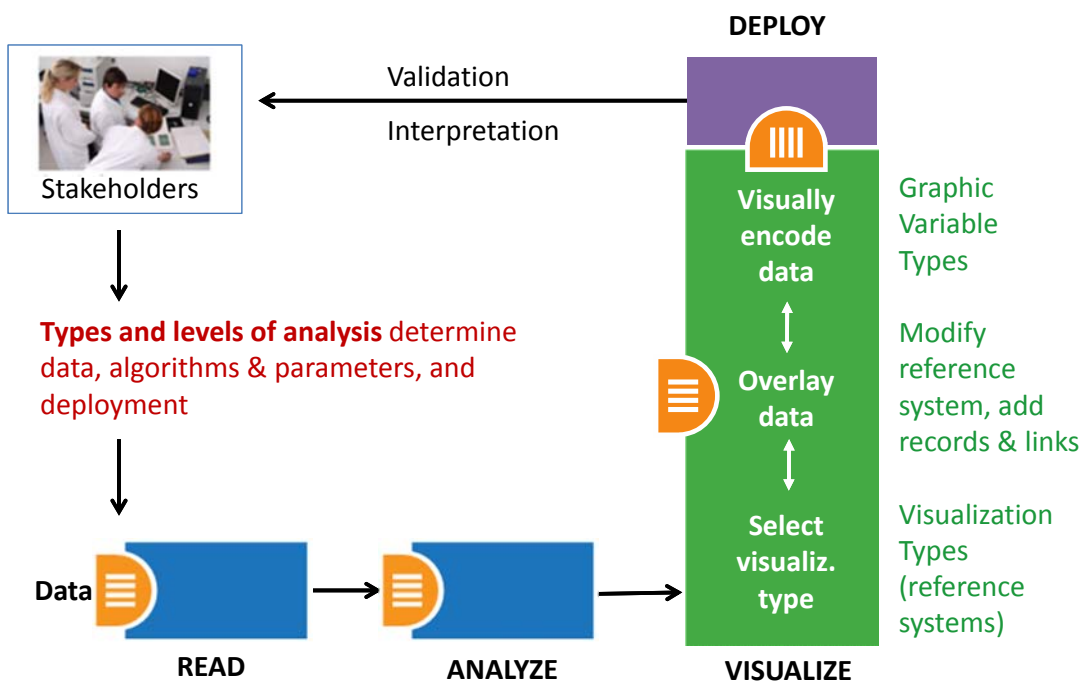
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Putting it all together: Line graph and U.S. map example



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Many visualizations used in the course come from the *Places & Spaces: Mapping Science* exhibit, online at <http://scimaps.org>, and from the *Atlas of Science: Visualizing What We Know*, MIT Press (2010).

