Two Phases

1. What to visualize

* Consider your inputs
  * your goals
  * their needs
  * shape of the data

* Write a spec for your visualization
  * select data to include

2. How to visualize

* Select axes for your most important data & relationship

* Consider & apply encodings for all other data dimensions

* Experiment, iterate, etc.
Three inputs.

Reader

Your visualization

Data

Designer
Define Desired Knowledge *Before*
Structure
What do you want to show?
What questions are you trying to answer?

What do you want to show?
What actions/decisions are you trying to enable?

What questions are you trying to answer?

What do you want to show?
Who is consuming this data?
What are their needs?
Who is consuming this data?

If not you:

- What are their priorities?
- What are their biases?
- What are their limitations?
- What don’t you know about them?
What data dimensions do you have to play with?
Data has properties.

- Wheel size: numeric (actually categorical)
- Tire width: continuous
- Price: continuous
- Anti-puncture: binary
- Foldable: binary
What types of data do you have?

* categorical (grouped)
* ordinal (ranked, time)
* quantitative (numeric)
* relational (hierarchy, influence, etc.)
* location (... it's complicated...)
What are the key relationships? 
(probably)
What are the key relationships?

What data is required to show them?
Define Desired Knowledge Before Structure
Statement of Goals
Show the relationship between A and B [and C...] across X [and Y] from m to n.
Show the relationship between A and B [and C...] across X [and Y] from m to n.

(“in order to determine our best and worst performing widgets.”)
What data are you actually going to use, based on that goal?

[A, B, X (from m to n)]
Now we start drawing.
Design strategies

- Limit the data & detail you include
- Use position for your most important relationship(s)
- Try different axes
- Consider default formats
- Use color for categories, not rank
- Encode other data and relationships with appropriate properties
Appropriate Encodings
### Properties and Best Uses of Visual Encodings

<table>
<thead>
<tr>
<th>Example</th>
<th>Encoding</th>
<th>Ordered</th>
<th>Useful values</th>
<th>Quantitative</th>
<th>Ordinal</th>
<th>Categorical</th>
<th>Relational</th>
</tr>
</thead>
<tbody>
<tr>
<td>position, placement</td>
<td>yes</td>
<td>infinite</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>1, 2, 3; A, B, C</td>
<td>text labels (alphabetical or numbered)</td>
<td>optional</td>
<td>infinite</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>length</td>
<td>yes</td>
<td>many</td>
<td>Good</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>size, area</td>
<td>yes</td>
<td>many</td>
<td>Good</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>angle</td>
<td>yes</td>
<td>medium/few</td>
<td>Good</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pattern density</td>
<td>yes</td>
<td>few</td>
<td>Good</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight, boldness</td>
<td>yes</td>
<td>few</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>saturation, brightness</td>
<td>yes</td>
<td>few</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>color</td>
<td>no</td>
<td>few (&lt; 20)</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shape, icon</td>
<td>no</td>
<td>medium</td>
<td>Good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pattern texture</td>
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<td>enclosure, connection</td>
<td>no</td>
<td>infinite</td>
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<td></td>
</tr>
<tr>
<td>line pattern</td>
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<td>few</td>
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<td></td>
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<td></td>
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<tr>
<td>line endings</td>
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<td>few</td>
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Noah Iliinsky • ComplexDiagrams.com/properties • 2012-06

Position is Everything.
How can you use position to reveal your key relationship(s)?
Is there a good default format for this kind of relationship?
List (at least) three possible combinations of axes.
List (at least) three possible combinations of axes.

If you have a tool, try graphing each of these permutations.
Appropriate Encodings
What are good options for encoding your other data dimensions?
### Properties and Best Uses of Visual Encodings

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http://ComplexDiagrams.com/properties
Pick encodings for your remaining data dimensions.

See how that looks.
Design strategies

- Limit the data & detail you include
- Use position for your most important relationship(s)
- Try different axes
- Consider default formats
- Use color for categories, not rank
- Encode other data and relationships with appropriate properties
Iterate, iterate, iterate.
Tools

- **d3.js**: structured frameworks
- **processing**: flexible, freeform
- **R + ggplot2**: stats & analytics
- **Tableau**: visual exploration & analytics

- **ColorBrewer** for selecting color palettes
- **ChartChooser** for selecting graph style
- **ComplexDiagrams.com/properties**
Thank you!

@noahi
gmail: iliinsky
ComplexDiagrams.com

Book signing
Wednesday 10:20 am

Office hours
Wednesday 1:30 pm

How to do it
(this talk)

How they did it
(20 case studies)
Visualization for persuasion (or propaganda)
Visualization for persuasion (or propaganda)
Wrong!
Right!
Wrong!
Apple or Orange Juice Consumption

Orange Juice
74 lbs per capita

Apple Juice
27 lbs per capita

It looks as if orange juice is the clear winner, but...
Wrong!

http://www.smarter.org/research/apples-to-oranges/
Valid 3D
Wrong!

http://www.digitalsurgeons.com/facebook-vs-twitter-infographic/
Use a format that fits the data
Right!

http://www.futurechanges.org/2009/11/12/eisenhower-interstate-system-london-underground-style-map/
Right!

http://sanfrancisco.crimespotting.org/
**Periodic Table of Beer Styles**

<table>
<thead>
<tr>
<th>Style number</th>
<th>Style name</th>
<th>Key to yeast type</th>
<th>Original gravity</th>
<th>Key to yeast type</th>
<th>Final gravity</th>
<th>SRM rating</th>
<th>Style family key</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Faro</td>
<td>Ale yeast with lactic bacteria</td>
<td>1.044-1.056, 1.008-1.016</td>
<td>Ale yeast</td>
<td>12-20</td>
<td>4-6.5, 15-50</td>
<td>XIV</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ale**

1. Wheat beer
2. Lambic & Sour ale
3. Belgian ale
4. Pale ale
5. English Bitter
6. Scotch ale
7. Brown ale
8. Porter
9. Stout
10. Pilsner

**Lager**

1. American lager
2. European lager
3. Bock
4. Alt
5. French ale
6. German Amber Ale
7. American Special
8. Barley Wine
9. Strong Ale

**Mixed Styles**

- Kölsch
- Bière de garde
- Oktoberfest
- Cream ale
- Smoked beer
- Barleywine
- Strong “scotch” ale

**Notes**

- "Ale" styles are characterized by their fermentation with yeast that remains in the beer, while "Lager" styles are fermented with yeast that settles out of the beer.

- The "Mixed Styles" category includes beers that fall between the two main categories.

- The "SRM rating" refers to the Standard Reference Method for measuring the color of beer.

- ABV stands for Alcohol by Volume.

- IBU stands for International Bitterness Units.

---

[Periodic Table of Beer Styles](http://www.gunaxin.com/wp-content/uploads/2009/12/dhfq8m.jpg)
Google APIs & Developer Products – January 2011

Wrong!

http://code.google.com/more/table/
# A Periodic Table of Visualization Methods

<table>
<thead>
<tr>
<th>Data Visualization</th>
<th>Strategy Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual representations of quantitative data in schematic form (either with or without axes)</td>
<td>The systematic use of complementary visual representations in the analysis, development, formulation, communication, and implementation of strategies in organizations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information Visualization</th>
<th>Metaphor Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of interactive visual representations of data to simplify cognition. This means that the data is transformed into an image, it is mapped to screen space. The image can be changed by users as they proceed working with it</td>
<td>Visual Metaphors position information graphically to organize and structure information. They also convey an insight about the represented information through the key characteristics of the metaphor that is employed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept Visualization</th>
<th>Compound Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods to elaborate (mostly) qualitative concepts, ideas, plans, and analyses.</td>
<td>The complementary use of different graphic representation formats in one single schema or frame.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process Visualization</th>
<th>Structure Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: Depending on your location and connection speed it can take some time to load a pop-up picture.</td>
<td>© Ralph Lengler &amp; Martin J. Eppler: <a href="http://www.visual-literacy.org">www.visual-literacy.org</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overview</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Su supply demand curve</td>
<td>St strategy map</td>
</tr>
<tr>
<td>Pc performance charting</td>
<td>Oc organisation chart</td>
</tr>
<tr>
<td>Ho house of quality</td>
<td>Ft failure tree</td>
</tr>
<tr>
<td>Mq magic quadrant</td>
<td>Ld life-cycle diagram</td>
</tr>
<tr>
<td>Po porter’s five forces</td>
<td>Ss stakeholder map</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detail AND Overview</th>
<th>Divergent thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed edgeworth box</td>
<td>Pf portfolio diagram</td>
</tr>
<tr>
<td>Sg strategic game board</td>
<td>Mz mietzberg’s organisograph</td>
</tr>
<tr>
<td>Zc zwick’s morphological box</td>
<td>Ad affinity diagram</td>
</tr>
<tr>
<td>De decision discovery diagram</td>
<td>Bm beg matrix</td>
</tr>
<tr>
<td>Sc strategy canvas</td>
<td>Vc value chain</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Convergent thinking</th>
<th>Hy hyper-cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergent thinking</td>
<td>Sr stakeholder rating map</td>
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</table>

http://www.visual-literacy.org/periodic_table/periodic_table.html
The Periodic Table of Controllers

Console and handheld

http://web.me.com/mvasilev/mikevasilev.com/PTOC.html

Wrong!
The Evolution of Controllers