Why do we need visualizations?
External aids enhance our **cognitive abilities**

**Context** is key to understanding

There is **not a single answer** to a given problem

Solving a design problem requires finding the **right representation**

**Human-centered design**: understanding our constraints and capabilities
information design
infographics communicate information with the purpose to reveal patterns and relationships not known or not easily deduced without the aid of visual representations

information visualization
data visualization
the use of computer-supported, interactive, visual representations of abstract data to amplify cognition
Card et al. : Readings in Information Visualization
The real powers come from devising external aids that enhance cognitive abilities. How we increase memory, thought, and reasoning? By the invention of external aids: It is things that make us smart.

Donald A. Norman
Things that Makes Us Smart (1993), 43
Cognitive principles behind information visualization:

- to convey meaning
- to increase working memory
- to facilitate search & discovery
- to support perceptual inference
- to enhance detection & recognition
- to provide models of actual & theoretical worlds
- to provide manipulation of data
14th century Virtues, Vices, and the Sciences Dichotomy.
16th ct. printed work by the Spanish scholar Juan de Celaya
1274 Hand of Guido: utilization of mnemonic hands as part of medieval musical theory.
1550 Giulio Camillo: The Memory Theater.
Isaac Newton’s 1665 sketch of experiment on light and color prism to generate color spectrum. Charles Darwin’s 1870 sketch for an Evolutionary Tree.
13th century World Map

1989 original concept of the World Wide Web by Tim Berners-Lee (while at CERN, Switzerland)
External aids enhance our cognitive abilities
Always design a thing by considering it in the next larger context:

- a chair in a room,
- a room in a house,
- a house in an environment,
- an environment in a city plan.

Eliel Saarinen
Context is key to understanding
Canada

Super Typhoon Rammasun due to hit Vietnam

Brazil

More 11 Palestinian morts during Israeli offensive in Gaza

USA

Washington wildfires destroy about 100 homes

UK

Obama says destruction of MH17 is a 'wake-up call' for Europe

lesson 2

Information visualizations are good at providing context and uncovering patterns that can facilitate decision-making.
There is not a single answer to a given problem
Max Fürbringer (1888): Diagrams representing the “Phylogenetic Tree of Birds”
M. Stefaner et al. (2009): http://well-formed.eigenfactor.org
Vidal et al.: The Human Disease Network
Poster :The PNAS in 2007
Design entails compromise and depends largely on the task and target audience.
The brain is a powerful pattern-finding engine...

If we can transform data into the appropriate visual representation, its structure may be revealed.

Colin Ware

Justin Matejka et al. (Autodesk), 2011 > www.autodeskresearch.com/projects/citeology
Solving a problem requires finding the right representation.
5 Perceptual and Cognitive capabilities and constraints
information designer

encode

develop

target audiences

decode
Constraints:

Perceptual systems
Cognitive processes
Data types
Dimensions of medium
Representation types
Prior knowledge
Believes

René Descartes (1664):
The Process of Visual Perception
see verb 1. I can see the house make out, catch sight of, glimpse, spot, notice, observe, view, perceive, discern, espy, descry, distinguish, identify, recognize. 2. see that man over there look at, regard, note, observe, heed, mark, behold, watch; inf. get a load of. 3. saw a movie last night watch, look at, view. 4. see what they mean understand, grasp, get, comprehend, follow, take in, know, realize, get the drift of, make out, fathom; inf. latch on to. 5. go and see what he wants find out, discover, learn, ascertain, determine, ask, inquire, make inquiries into/about, investigate. 6. we will have to see think, consider, reflect, deliberate, give thought, have a think.

understand verb 1. understand his meaning | understand what he says comprehend, apprehend, grasp, see, take in, perceive, discern, make out, glean, recognize, appreciate, get to know, follow, fathom, get to the bottom of, penetrate, interpret; inf. get the hang/drift of, catch on, latch on to, figure out. 2. I understand your feelings/position appreciate, accept, commiserate with, feel compassionate toward, sympathize with, empathize with. 3. I understand that he has left gather, hear, be informed, learn, believe, think, conclude.
Perceptual constraints

Ishihara test image

Chyntia Brewer color tool > http://colorbrewer2.org/
**Data types constraints**

Nominal: A, B, C are distinguishable

Ordinal: B is between A and C

Quantitative: BC is twice as long as AB
**Bertin’s system: perceptual variables**

<table>
<thead>
<tr>
<th>VARIABLES OF THE IMAGE</th>
<th>VISUAL ELEMENTS</th>
<th>SIGNIFYING PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POINT</strong></td>
<td><img src="image" alt="Point Elements" /></td>
<td><img src="image" alt="Quantitative" /></td>
</tr>
<tr>
<td><strong>LINE</strong></td>
<td><img src="image" alt="Line Elements" /></td>
<td><img src="image" alt="Ordered" /></td>
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<tr>
<td><strong>AREA</strong></td>
<td><img src="image" alt="Area Elements" /></td>
<td><img src="image" alt="Selective" /></td>
</tr>
</tbody>
</table>

**DIFFERENTIAL VARIABLES**

| Texture | ![Texture Elements](image) | ![Associative](image) |
| Color   | ![Color Elements](image)   | ![Dissociative](image) |
| Orientation | ![Orientation Elements](image) |                     |
| Shape   | ![Shape Elements](image)   |                       |

**J. Bertin (1967): Semiologie Graphique**
Graphics can mislead

Axes / ratios:

Topologies:
Paul Butler (Facebook), 2010: Map visualizing friendships in Facebook around the globe
lesson 5

Visualizations are human-centered artefacts
thanks!

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