Software Visualization

Leonel Merino

Adapted from slides by Mircea Lungu
The lines on the buildings are proportional to the number of deaths due to cholera from those buildings.

Do you know how did Snow realize which was the cause of cholera by looking at this map?
[Anscombe '73]
Roadmap

> Visual Perception
> Information Visualization
> Software Visualization
Roadmap

> Visual Perception
> Information Visualization
> Software Visualization
We acquire more information through vision than all the other senses combined.
Pre-attentive Processing

“Typically, tasks that can be performed on large multi-element displays in less than 200-250 milliseconds (msec) are considered pre-attentive.”

[Healy and Enns ’12]
orientation
length
size
density
hue
luminance
intersections

terminators

3D depth

flicker
direction of motion

velocity of motion

lighting direction
Preattentive Processing: Color
Preattentive Processing: Color
Gestalt Psychology

> The Gestalt Laws

1. Simplicity
2. Closure
3. Similarity
4. Proximity
5. Continuity
1. Law of Simplicity

> Reality is organized and reduced to the simplest form possible
1. Law of Closure

> The mind completes missing parts so it can see a simple image
2. Law of Similarity

> The mind groups similar elements together
3. Law of Proximity

Spatial (or temporal) proximity induces the mind to see a totality
4. Law of Continuity

> Lines follow the smoothest and simplest path.
Roadmap

> Visual Perception
> Information Visualization
> Software Visualization
“The use of computer-supported interactive, visual representations of abstract data to amplify cognition.”

[Card et al., 1999]
Data-Driven Principles of Visualization Design

Quantitative
- Position
- Length
- Angle
- Area
- Gray ramp
- Color ramp
- Color hue
- Shape

Ordinal
- Position
- Gray ramp
- Color ramp
- Color hue
- Length
- Angle
- Area
- Shape

Nominal
- Position
- Shape
- Color hue
- Gray ramp
- Color ramp
- Color ramp
- Length
- Angle
- Area

[Mackinlay, 1986]
Uncovers emergent properties and outliers
Exposes problems with the dataset

“Hippo”
• Industrial System
• 1M LOC
• >10K Files
• >100 Authors

Can you see a certain suspect symmetry in the interaction between the subsystems of this project?
Enhances communication
Uses of Information Visualization

> Supports analysis
  – Uncovers emergent properties and outliers
  – Exposes problems with the data set
> Enhances communication
Roadmap

> Visual Perception
> Information Visualization
  — Visualization Principles [Intermezzo]
> Visualizing Software
Good information visualization is based on **style, integrity, and design**.
Removing ink from your graph should remove meaning from it.
The length of an organism at the time of reproduction in relation to the generation time, plotted on a logarithmic scale.
Design: Choose the appropriate representation
Estimates of relative survival rates, by cancer site
Integrity: Present only the data

This cluster of type emphasizes and stretches out the low value for 1966–1967, encouraging the impression that recent years have shot up from a small, stable base. Horizontal arrows provide similar emphasis.

This squeezed-down block of type contributes to an image of small, squeezed-down budgets back in the good old days.

Arrows pointing straight up emphasize recent growth. Compare with horizontal arrows at left.
Improvement 1: Eliminate Chart Junk

Leaving behind the distortion in the chartjunk heap at the left yields a calmer view:
Improvement 2: Adjust the underlying information...
Roadmap

- Visual Perception
- Information Visualization
- Software Visualization
SV is the use of interactive computer graphics to enhance the interface between users and their programs.

[Price, 1992]
Roadmap

> Visual Perception
> Information Visualization
> **Software Visualization**
  > Structure
  > Evolution
  > Behavior
Space Filling Techniques

> Use of pre-attentive processing features of
  — Locality
  — Size

> Types
  — Treemaps
  — Voronoi diagrams
Providing an overview of size distribution
Polymetric Views

> Use of pre-attentive processing features
  — Size
  — Color
  — Connectedness

> Implemented in…
  — Mondrian, Roassal,
  — XRay
Providing an overview of inheritance
3D Polymetric Views

> Use of pre-attentive processing features of
  — Size
  — Color
  — 3D spatial locality

> Implemented in…
  — CodeCity (and clones)
Detecting outliers

LOC  ->  Color
NOM  ->  Height
NOA  ->  Area
Communicating the locality of problems

Marcel Bruch @MarcelBruch · 2h

Wanna know which parts of your code cause loads of errors? This is the new "Sin City of Code":

[Image of a 3D model representing code locality]
Hierarchical Visualization

> Use of pre-attentive processing features of
  — Size
  — Spatial locality
  — Connectedness
  — Color

> Implemented in…
  — Softwarenaut, Rigi, Shrimp, etc.
An overview of the dependencies between the various parts of the system.
Structure — Summary

> Visualized Aspects
  — Inheritance
  — Containment
  — Dependencies

> Techniques
  — Polymetric Views
  — 3D Polymetric Views
  — Hierarchical Visualization
  — Space filling techniques
Roadmap

> Visual Perception
> Information Visualization
> **Software Visualization**
  — Structure
  — **Evolution**
  — Behavior
Mapping evolution on time
The Seesoft system maps each line of code into a thin row. The color of each row indicates a statistic of interest, e.g., red rows are those most recently changed, and blue are those least recently changed.
Mapping evolution on space (the x-axis)
Y-axis represents individual files sorted alphabetically
Map authors on colors and kill alphabetical order
System evolution can be mapped on

time  color  space
Roadmap

> Visual Perception
> Information Visualization
> **Software Visualization**
  — Structure
  — Evolution
  — **Behavior**
Zinsight visualization is targeted at analyzing large event traces
Massively reliant on visual pattern recognition and interactivity

Semantic Zooming
Visual detection of bugs
Ceci n’est pas une visualization.
What you should know

> What is pre-attentive processing?
> What are the laws of Gestalt psychology?
> What is information visualization good for?
> Which aspects of software can be visualized?
> Which techniques are used in visualizing software structure?
> On what visualization features can we map evolution?
> What kinds of problems can be solved with software visualization?
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