Software Visualization

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?
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.
# Preattentive Processing

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Line Length</th>
<th>Line Width</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>Curvature</td>
<td>Added Marks</td>
<td>Enclosure</td>
</tr>
</tbody>
</table>
Preattentive Processing: Color

87893640823764031287645329847329847320948732908453
89274-0329874-32874-2319847509834098340983240983204
9823-0984903281453209481-0839393947896587436598
Preattentive Processing: Color

87893640823764031287645329847329847320948732908453
89274-0329874-32874-23198475098340983409832409832049823-0984903281453209481-0839393947896587436598
Gestalt Psychology

> The law of simplicity
> The Gestalt Laws
  1. Closure
  2. Similarity
  3. Proximity
  4. Continuity

“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.
Uncovers emergent properties and outliers
Exposes problems with the dataset

Can you see a certain suspect symmetry in the interaction between the subsystems of this project?

“Hippo”
- Industrial System
- 1M LOC
- >10K Files
- >100 Authors
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.
Style: Minimize Non-Data Ink

Removing ink from your graph should remove meaning from it.
Relationship of Actual Rates of Registration to Predicted Rates
(104 cities 1960).
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

<table>
<thead>
<tr>
<th>Cancer Site</th>
<th>% Survival Rates and Standard Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 year</td>
</tr>
<tr>
<td>Prostate</td>
<td>98.8</td>
</tr>
<tr>
<td>Thyroid</td>
<td>96.0</td>
</tr>
<tr>
<td>Testis</td>
<td>94.7</td>
</tr>
<tr>
<td>Melanomas</td>
<td>89.0</td>
</tr>
<tr>
<td>Breast</td>
<td>86.4</td>
</tr>
<tr>
<td>Hodgkin's disease</td>
<td>85.1</td>
</tr>
<tr>
<td>Corpus uteri, uterus</td>
<td>84.3</td>
</tr>
<tr>
<td>Urinary, bladder</td>
<td>82.1</td>
</tr>
<tr>
<td>Cervix, uteri</td>
<td>70.5</td>
</tr>
<tr>
<td>Larynx</td>
<td>68.8</td>
</tr>
<tr>
<td>Rectum</td>
<td>62.6</td>
</tr>
<tr>
<td>Kidney, renal pelvis</td>
<td>61.8</td>
</tr>
<tr>
<td>Colon</td>
<td>61.7</td>
</tr>
<tr>
<td>Non-Hodgkin’s</td>
<td>57.8</td>
</tr>
<tr>
<td>Oral cavity, pharynx</td>
<td>56.7</td>
</tr>
<tr>
<td>Ovary</td>
<td>55.0</td>
</tr>
<tr>
<td>Leukemia</td>
<td>42.5</td>
</tr>
<tr>
<td>Brain, nervous system</td>
<td>32.0</td>
</tr>
<tr>
<td>Multiple myeloma</td>
<td>29.5</td>
</tr>
<tr>
<td>Stomach</td>
<td>23.8</td>
</tr>
<tr>
<td>Lung and bronchus</td>
<td>15.0</td>
</tr>
<tr>
<td>Esophagus</td>
<td>14.2</td>
</tr>
<tr>
<td>Liver, bile duct</td>
<td>7.5</td>
</tr>
<tr>
<td>Pancreas</td>
<td>4.0</td>
</tr>
</tbody>
</table>
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...
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Roadmap

> Information Visualization
> Designing Visualizations
> **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
Nanna know which parts of your code cause loads of errors? This is the new 'Sin City of Code':
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
  — Polymeric Views
  — 3D Polymeric Views
  — Hierarchical Visualization
  — Space filling techniques

> Challenges
  — Displaying both structure and containment
Roadmap

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  — 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

color  space  time
Roadmap

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  > 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

> 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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