CSE 564
Visualization & Visual Analytics

Interaction & Information Navigation

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<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topic</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intro, schedule, and logistics</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Applications of visual analytics</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Basic tasks, data types</td>
<td>Project #1 out</td>
</tr>
<tr>
<td>4</td>
<td>Data assimilation and preparation</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Introduction to D3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Bias in visualization</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Data reduction and dimension reduction</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Data reduction and dimension reduction</td>
<td>Project #2(a) out</td>
</tr>
<tr>
<td>9</td>
<td>Visual perception and cognition</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Visual design and aesthetics</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>High-dimensional data visualization: linear methods</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>High-dimensional data visualization: non-linear methods</td>
<td>Project #2(b) out</td>
</tr>
<tr>
<td>13</td>
<td>Cluster analysis: numerical data</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Cluster analysis: categorical data</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td><strong>Principles of interaction</strong></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Midterm #1</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Visual analytics</td>
<td>Final project proposal call out</td>
</tr>
<tr>
<td>18</td>
<td>The visual sense making process</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Maps</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Visualization of hierarchies</td>
<td>Final project proposal due</td>
</tr>
<tr>
<td>21</td>
<td>Visualization of time-varying and time-series data</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Foundations of scientific and medical visualization</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Volume rendering</td>
<td>Project 3 out</td>
</tr>
<tr>
<td>24</td>
<td>Scientific and medical visualization</td>
<td>Final Project preliminary report due</td>
</tr>
<tr>
<td>25</td>
<td>Visual analytics system design and evaluation</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Memorable visualization and embellishments</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Infographics design</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Midterm #2</td>
<td></td>
</tr>
</tbody>
</table>
Too Much Data?

How can we deal with data overload

- see the forest for the trees (or the other way around)
Too Much Data?

Internet routes (1/15/2005)

(NY Museum of Modern Art)
Allow users to control what is currently shown:

- level of detail
- extent of the data (spatial, values)
- aspects of the data (attributes)

But do not leave the user lost in the forest

- provide navigation hints

Two powerful paradigms:

- overview, and detail on demand (forest and trees)
- focus and context (trees and forest)

Interaction needs to be interactive (as in responsive)

- user needs get quick visual feedback on actions
Interaction: Key to Visual Analytics

Puts the human in the loop
  • appeals to human’s expertise and intuition

Requires a suitable human-computer interface
  • recall the lectures on color and perception

Interaction can help with:
  • making sense of it all
  • putting things in proper context
  • data overload (scalability)
  • telling stories with data (explain findings to others)

Evaluate effectiveness
  • do human users actually benefit?
  • user studies!
Stephen Few (chapter 4):

- compare
- sort
- add variables
- re-scale
- re-express
- filter
- highlight
- annotate
- bookmark
- aggregate
- re-visualize
- zoom and pan
- details on demand
Example

Assume you have been offered a car to buy

- assume you are mostly interested in horsepower, weight, acceleration
- the car you have been offered has 60 hp, 1834 kg, 8 s
Compare

See the car with other available cars

Horsepower

hard to see how it really ranks
See the car in the context of other available cars.

It is a low-horsepower car.
Is horsepower correlated to weight?
• are there trade-offs?

hard to see what is going on
Scale horsepower into the same range than weight

- could also normalize each to (0.0, 1.0)

There seems to be a positive correlation

- cars with higher horsepower are also heavier
How does it relate to acceleration?

non-intuitive that acceleration is less for high horsepower cars
Acceleration should really be $1/\text{acceleration}$

- should be measured in $1/\text{sec}$ (and not sec)

- now higher horsepower cars also seem to have higher acceleration (but the influence is quite minor) $\rightarrow$ is there a higher-D relationship?
Filtering

Example: Graph of concepts

- related concepts group closer

from: http://www.mkbergman.com/date/2008/02/
Filtering

Example: Graph of concepts

- only keep top 750 connected nodes
Filtering

Example: Graph of concepts
  • only keep top 350 connected nodes
Zooming

Example: Graph of concepts
- only keep Saab neighborhood
Zooming

Example: Graph of concepts
• only keep Saab neighborhood, zoom in more
As discussed, good ways to aggregate all data into a single display are:

- biplots (project all data into a PCA vector basis)
- multidimensional Scaling (MDS)
- parallel coordinates
The Visual Information-Seeking Mantra

- devised 1996 by Ben Shneiderman (U Maryland, College Park)
- summarizes many visual design guidelines
- in some ways inspired by human vision/behavior
- provides an excellent framework for designing Information visualization applications.

Overview, zoom and filter, then details-on-demand
Overview and Detail

Information space overview plus some detail

• maintains (some) context with the detail currently focused on

Leica Microsystems

WikiViz
Focus + Context

Overview and detail

• disjoint views, maybe connected by a fan
• but: they simultaneously shows both overview and details
• require the viewer to consciously shift his/her focus of attention

Focus + context

• one single view which shows information in direct context
• maintains continuity across the display
• do not require viewer to shift back and forth
• a good F+C paradigm is the lens
• but: there will be distortion
Fisheye Lenses

Fisheye lenses

• physically correct and therefore familiar
• keep target item in focus
• less relevant peripheral items are dropped or reduces in size
• distortion
Bifocal Lens

Complete Mapped Information Space

Principle of the Bifocal Display

Bifocal Display Seen by the User
Bifocal Lens

London subway map
Avoid aliasing in transition regions by low-pass filtering.
Generalized Lenses

Computers can go beyond (stretch) the laws of physics
  • example: multi-perspective lens rendering, gaze-directed, …

Rademacher/Bishop

MC Escher

Loeffelmann/Groeller
Generalized Lenses

no lens

Wang et al., 2005
Lenses in Information Visualization

Hyperbolic Tree fisheye lens

- Xerox PARC/Inxight
- selectively and smoothly reduce complexity as user focus changes
Lenses in Information Visualization

**Table Lens** (Rao and Card, 1994)
- uses a DOI (degree of interest) lens
- fuses symbolic and graphical detail driven by the DOI lens
Perspective Wall

- Xerox PARC/Inxight
- details on the center panel are at least three times larger than the details on a flat wall that fits the field of view
Illustrating the concept of a magic lens. (a) shows a conventional map of an area, (b) shows the location of services (gas, water and electricity pipes) in the same area, and (c) a (movable) magic lens shows services in an area of interest, in context.
Zoom and Pan

Panning
• smooth movement of a viewing frame over a 2D image of greater size

• Zooming
• increasing magnification of a decreasing fraction (or vice-versa) of a 2D image under the constraint of a viewing frame of constant size

Transfer of the focus of attention:
• zoom out → pan → zoom in
Efficient transfer of the focus of attention:

- zoom out → pan → zoom in

Furnas, Bederson, 1995
Scale-Space Diagrams Application

video on youtube
Intelligent Zooming

Depending on scrolling speed, zoom more or less

- allows efficient navigation of large documents
- employs semantic zooming

Igarashi, Hinckley, 2000
Semantic Zoom

Standard zoom:
shows a down/up scaled version of the object/image

Semantic zoom:
• shows a different representation determined by the space available
Semantic Zooms: Maps
Semantic Zoom: The Finite Microscope
What to do normally, in this case:

• switch to the dataset acquired with suitable modality (higher resolution)
Apply constrained multi-scale texture synthesis to facilitate semantic zooms

Semantic Zoom: The Infinite Microscope

Zoom in

Region of Interest

Output image

Level 1

Level 2

Level 3

Synthesize new detail

Synthesize new detail

...
Semantic Zoom: The Infinite Microscope

Apply constrained multi-scale texture synthesis to facilitate semantic zooms
Data collection (sample images)

Colorization

• reduce the distinct discontinuities during zoom

Sample Images

MRI level  histology level  cell level
Data collection (sample images)

Colorization
  • reduce the distinct discontinuities during zoom

Segmentation (to enable constrained synthesis)

MRI level
histology level
cell level

Tag Images
Constrained Synthesis

Standard L-neighborhood will not work
  • distance and shape dependencies exist

Rotated L-neighborhood

Sample texture

Distance and gradient fields

Reference distance and gradient fields

Synthesized texture
Example: Skin Histology

- Sample image
- Distance and gradient fields
- Reference distance and gradient fields
- Synthesized skin histology image
Smooth Semantic Zooms

Magnify low resolution level image
Synthesize new detail at transition point
Minify synthesized next high level image
Weighted Blending

\[ \text{Present image} \quad \xrightarrow{\text{Transition point}} \quad \text{Newly synthesized image} \]

\[ \text{weight} = 1 \quad \text{weight} = 0 \]
Semantic Zoom: The Infinite Microscope
Semantic Zoom: The Infinite Microscope Still Frames
Semantic Zooms: Information Visualization

Could show different levels/aspects of information

- on a map, show either parking lots, bars, or restaurants
- zoom in by price range (cheap first, then more expensive…)
- zoom in by preference (favorite food first, then less favorite…)
- may combine these criteria into a preference function
Semantic Zooms: Information Visualization

Could show different levels/aspects of information

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Zoom levels may require access rights

- members only
- big wallets only
- classified information

Human being  Male  Police man  British policeman  Inspector Blanding

information access rights
An Exploded View Paradigm to Disambiguate Scatterplots

video
Interactive technique

- Highlighting
- Brushing and Linking

At least two things must be linked together to allow for brushing

- select a subset of points
- see the role played by this subset of points in one or more other views

Example systems

- Graham Will’s EDV system
- Ahlberg & Sheiderman’s IVEE (Spotfire)
select high salaries

how long in majors

avg. assists (x) vs. avg. putouts (y) (fielding ability)

distribution of positions played

avg. career home runs (y) vs. avg. career hits (x) (batting ability)

Baseball Data: Scatterplots and Histograms and Bars

anything interesting?
What was Learned from Interaction w/ the Baseball Data?

• Seems impossible to earn a high salary in the first three years
• High salaried players have a bimodal distribution (peaking around 7 & 13 yrs)
• Hits/Year a better indicator of salary than HR/Year
• High paid outlier with low HR and medium hits/year. Reason: person is player-coach
• There seem to be two differentiated groups in the put-outs/assists category (but not correlated with salary) Why?
Brushing: Highlighting

Use mouse interaction to highlight points and lines in

- parallel coordinates
- scatterplots
Interaction in Parallel Coordinate
Dashboards should pass the 5-second test
Important rules:

• most important view goes on top or top left
• legends go near their views
• avoid using multiple color schemes
• use 5 views or fewer
• provide interactivity