Overview and Detail + Focus and Context

CS 7450 - Information Visualization
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Fundamental Problem

- **Scale** - Many data sets are too large to visualize on one screen
  - May simply be too many cases
  - May be too many variables
  - May only be able to highlight particular cases or particular variables, but viewer’s focus may change from time to time
Large Scale

- One of the fundamental challenges in information visualization
  - How to allow end-user to work with, navigate through, and generally analyze a set of data that is too large to fit in the display
  - Potential solutions lie in
    - Representation
    - Interaction
    - Both

One Solution :^)

You can just buy more pixels

Problem: You’ll always eventually run out of pixels
Overview

• Providing an overview of the data set can be extremely valuable
  – Helps present overall patterns
  – Assists user with navigation and search
  – Oriented activities

• Generally start with overview
  – Shneiderman mantra

Details

• Viewers also will want to examine details, individual cases and variables

• How to allow user to find and focus on details of interest?

• Generally provide details on demand
Providing Both

- Overview + detail displays can be combined via either time or space
  - Time - Alternate between overview and details sequentially in same place
  - Space - Use different portions of screen to show overview and details

- Each has advantages and problems
- Hybrid approaches exist

Specific Problem

- Develop visualization and interface techniques to show viewers both overview + detail, and allow flexible alternation between each

- Potential Solutions????
  - Discuss....
One Common Solution

• Pan/Scroll
  – Provide a larger, virtual screen by allowing user to move to different areas

• Still a problem
  – Clunky interaction
  – Only get to see one piece

Another Solution

• Zoom
  – Zoom out shows an overview of data space then zooming in allows viewer to examine details
Zooming


http://htwins.net/scale2/

Similar Idea
Understanding Zooming

- Introduction of idea of “space scale diagram”
- Characterizes operations in zooming through this new diagram they introduce
- Goals
  - Understand multiscale systems
  - Guide design
  - Authoring tool

Space-Scale Diagram

Technique for describing panning and zooming interfaces
Pad -> Pad++ -> Jazz -> Piccolo

- Environments for supporting flexible, smooth zooming and panning on structured graphics world
  - Pad - Perlin & Fox, NYU
  - Pad++ - Bederson & Hollan, Bellcore & New Mexico
  - Jazz - Bederson, Maryland
  - Piccolo, Bederson, Maryland

Toolkit Characteristics

- Support library for building applications
- Infinite plane, panning in x-y, zooming in-out
- 2.5-D, not 3-D
- Important concepts
  - Portals
  - Lenses
  - Sticky objects
  - Semantic zooming
Efficiency Measures

- Level of detail
  - Render items depending on how large they are on screen, don’t draw small ones
- Refinement
  - Render fast with low detail while moving, refine image when still
- Region management
  - Only update portion of screen that has been changed
- Interruption
  - User input takes precedence, moves animations to their end state, gets handled

Pad++ Applications

- PadDraw
  - Simple graphics editor
- File/Directory browser
Applications

Timeline views

Example: Web History

Web traversal history

PadPrints

Hightower et al
UIST '98

Video
Browsing Images

PhotoMesa

Uses panning and zooming to browse a photo collection

Bederson
UIST ’01

Demo & Video:
www.cs.umd.edu/hcil/photomesa

Presenting Talks

CounterPoint

Uses panning and zooming in PowerPoint

Good & Bederson
Information Visualization ’02

Demo:
www.cs.umd.edu/hcil/counterpoint
Many More Applications


Current Status

http://www.piccolo2d.org/

Piccolo has an active user base
Other Systems

- Let’s see some other examples...

Wing

- Another system providing zooming techniques
- Provides zooming on an index or table of contents to see more detail
- Integrated with multi-window overview and detail multimedia tool

Masui, et al
UIST ’95

Video
FacetZoom

- Combine (hierarchical) facets with zooming UI for exploration

Example Application

http://prezi.com
Issues

• Getting lost
  – Zoom in or out way too far
  – Can’t see anything

• Termed “Desert fog” by Jul and Furnas

Videos

Optimal Actions

• Sometimes, these kinds of UIs can be disorienting to viewer

• Example
  – Long pan isn’t any good
  – Better: Zoom out, pan a little, zoom in
Other Alternatives

- Allow viewer to examine cases and/or variables in detail while still maintaining context of those details in the larger whole
- Concession
  - You simply can’t show everything at once
- Be flexible, facilitate a variety of user tasks
Nature of Solutions

- Not just clever visualizations
- Navigation & interaction just as important
- Information visualization & navigation

Confound

Devices with even smaller screens are becoming more popular!
An Example

Overview and detail (from *Civilization II* game)

Survey of Techniques

- Application concern: viewing and editing large images
- Expanding the notion of the one dimensional scroll bar: zooming, diagonal panning, multiple detailed views
- List of visualization/interaction solutions...

Plaisant et al
*IEEE Software* ’95
1. Detail-only

- Single window with horizontal and vertical panning
- Works only when zoom factor is relatively small
- Example: Windows

2. Single window with zoom and replace

- Global view with selectable zoom area which then becomes entire view
- Variations can let users pan and adjust zoomed area and adjust levels of magnification
- Context switch can be disorienting
- Example: CAD/CAM
3. Single coordinated pair

- Combined display of the overview and local magnified view (separate views)
- Some implementations reserve large space for overview; others for detail
- Issue: How big are different views and where do they go?

4. Tiled multilevel browser

- Combined global, intermediate, and detail views
- Views do not overlap
- Good implementations closely relate the views, allowing panning in one view to affect others
5. Free zoom and multiple overlap

- Overview presented first; user selects area to zoom and area in which to create detailed view

- Flexible layout, but users must perform manual window management

6. Bifocal magnified

- “Magnifying glass” zoomed image floats over overview image

- Neighboring objects are obscured by the zoomed window
7. Fish-eye view

- Magnified image is distorted so that focus is at high magnification, periphery at low
- All in one view
- Distortion can be disorienting
- More details coming...

Examples

- Let’s look at some specific techniques...
Magnifier Problem Fix

DragMag Image Magnifier

Bifocal magnified display without problem of obscuring the neighboring items

Video

Ware and Lewis
CHI '95

Transparent Overlays

Make detailed view semi-transparent, then overlay overview with it

May even control transparency of each

Lieberman
UIST '94
**Important Issue**

- The “overview” display may need to present huge number of data elements
- What if there simply isn’t enough room?
  - The number of data elements is larger than the number of pixels
  - (Recall Table Lens question?)

- Approaches?

**Two Main Approaches**

- 0. Interactive display (add scrolling)
  - Is it still an overview?
- 1. Reduce the data
  - Eliminate data elements
    - But then is it still an overview?
  - Aggregate data elements
- 2. Reduce the visual representation
  - Smart ways to draw large numbers of data elements
Drawing the Overview

Information Mural

What do you do when your data set is too large for your overview window?
--- More data points than pixels
--- Don’t want to fall back on scrolling

Use techniques of computer graphics (shading and antialiasing) to more carefully draw overview displays of large data sets

Think of each data point as ink and each screen pixel as a bin

Data points (ink) don’t fit cleanly into one bin, some ink may go into neighboring bins

Can map density to gray or color scale
Mural Algorithm

Mural Example

Object-oriented code executions

Detail

Overview

Focus
Mural Example

Sunspot activity over 150 years

Mural Example

Parallel Coordinates

normal

muralized

colorized
Mural Example

Message passing in parallel program

Mural Example

U.S. Census Data
Multiple Windows/Views

- Fundamentally, (good) overview & detail involves multiple views
- When should you use multiple views?
- What makes a good multiple view system?
Using Multiple Views

- We’ve seen many, many examples throughout the class so far
- What makes for an effective multiple view system?

Some important ideas

- Views can differ in their data or the representation of that data
- Design tradeoffs between cognitive aspects and system requirements
- Multiple views can decrease utility if not implemented correctly
- Three dimensions: selection, interaction and presentation of views
8 Guidelines

- Rule of Diversity: Use multiple views when there is a diversity of attributes
- Rule of Complementarity: Multiple views should bring out correlations and/or disparities
- Rule of Decomposition: “Divide and conquer”. Help users visualize relevant chunks of complex data

- Rule of Parsimony: Use multiple views minimally
- Rule of Space/Time Resource Optimization: Balance spatial and temporal benefits of presenting and using the views
- Rule of self Evidence: Use cues to make relationships apparent.
8 Guidelines

- Rule of Consistency: Keep views and state of multiple views consistent
- Rule of Attention Management: Use perceptual techniques to focus user attention

Challenge

- Have context/overview seamlessly and smoothly co-exist with focus/detail
- Why?
  - Easier to move between the two, helps assimilate view updates, less jarring, ...
- Not all overview and detail techniques are good at this
Focus + Context Views

- Same idea as overview and detail, with one key difference:
  - Typically, the overview and the detail are combined into a single display
  - Mimics our natural vision systems more closely

How?

- What techniques have we seen so far that would help accomplish focus+context?
Possible Methods

- Filtering
- Selective aggregation
- Micro-macro readings
- Highlighting
- Distortion

Prototypical Example

- When people think about focus+context views, they typically think of the *Fisheye View* (distortion)
- Introduced by George Furnas in 1981 report, more famous article is 1986 SIGCHI paper
Fisheye of Source Code

```c
#define DIG 40
#include <stdio.h>

main()
{
  int c, i, x[ DIG/4], t[ DIG/4], k = DIG/4, noprint = 0;
  while((c = getchar()) != EOF)
  {
    if(c >= '0' && c <= '9')
      else {
        switch(c){
          case ':'
            case 'c'
            case 'e'
            >> for(i=0;i<k;i++) t[i] = x[i];
            break;
            case 'q'
            default:
            };
        if(!noprint){
          ...
        }
      }
    noprint = 0;
  }
}
```

Furnas
CHI '86

Figure 4. A fisheye view of the C program. Line numbers are in the left margin. ".." indicates missing lines.

Definition

- **Fisheye View** -
  "Provide[s] detailed views (focus) and overviews (context) without obscuring anything...The focus area (or areas) is magnified to show detail, while preserving the context, all in a single display."

  -(Shneiderman, *DTUI*, 1998)
Everyday Life Example

Kinda Fisheye - Natural 3D Perspective
Why is it called Fisheye?

- Fisheye Camera Lens

On I-285, another Perimeter maul

Real fisheye camera lens

Atlanta Journal
Fisheye Terminology

- Focal point
- Level of detail
- Distance from focus
- Degree of interest function

Focal Point

- Assume that viewers focus is on some item, some coordinate, some position,...
Level of Detail

- Some intrinsic value or quantity on each data element
- How important is it to you in a general sense?
- Simplest example is that all data items have same level of detail

Distance from Focus

- Calculation of how far each data item is from the focal point
**Degree of Interest Function**

- Function that determines how items in display are rendered

- Degree of Interest = Level of Detail - Distance from Focus
  
  Level of Detail / Distance from Focus

![Diagram](image)

- Focal point: (0.8, 0.1)

**DoI Function**

- Can take on various forms
  - Continuous - Smooth interpolation away from focus
  - Filtering - Past a certain point, objects disappear
  - Step - Levels or regions dictating rendering
    - 0<x<.3 all same, .3<x<.6 all same
  - Semantic changes - Objects change rendering at different levels
Applications

Text/program viewing

Furnas’ original example

Shown here are examples from Gutwin and Greenberg

Step function

Applications

Shared text editor for CSCW

Gutwin and Greenberg

HCI ’96

Video
Applications

Viewing nodes in networks

Gutwin and Greenberg

Graphical Fisheye Views

- Apply fisheye techniques to 2D graph
- Experiment with a variety of distortion factors
- Interactive tool that allows user to browse display and change focus

Sarkar and Brown
CACM '94
Graphical Fisheye Views

Example

Original
Example

Constraining Changes

- Maybe we should limit changes in focus and context (eg, how context is represented) to make a more understandable representation...
Constraining Changes

• Continuous zoom
  – Can change focal point smoothly in graph
  – Other nodes give up space

Simon Fraser Univ.

Bartram et al
UIST '95

Constraining Changes

• Constrained fisheye
  – Make transitions in focus more aesthetically pleasing and easier to track

Simon Fraser Univ.

Storey et al
JVLC '99
Alternative Methodology

- We can think of focus and degree of interest as distorting or warping the space upon which data is presented
- Such pliable surfaces can provide another form of focus+context display

Carpendale, Cowperthwaite, Fracchia
IEEE CG&A’97

Carpendale and Montagnese
UIST ’01

Excellent Survey

- Review and Taxonomy of Distortion-Oriented Presentation Techniques
  - Surveys systems
  - Presents unified theory

Leung and Apperly
ToCHI ’94
Bifocal Display

- Interesting application of fisheye view
- View office documents
- Take items in periphery and fold back in 3-space
- Project onto front viewing screen

Spence & Apperly
BIT '82
Table Lens

From Xerox PARC and Inxight

A bifocal display

Rao & Card
CHI ’94

Perspective Wall

- Computerized, automated 3D implementation of Bifocal display
- Map work charts onto diagram, x-axis is time, y-axis is project

Mackinlay, Robertson, Card
CHI ’91

Video
Other 3D Approaches

Cone Trees
3D views of hierarchies such as file systems

Robertson, Mackinlay, Card
CHI '91

Fisheye Application

• The Problem
  – Menus have too many items
  – Especially a menu of data items (fonts)
  – Scrolling arrows & bars
  – Hierarchical groups

Bederson
UIST '00
Existing Options

Fisheye Menus

- Dynamically change size of menu item & provide focus area around the pointer
- Items near cursor displayed at full size
- Items further away on either side are smaller
- Uses a distortion function so items will always fill menu
Focus Lock

- Problem of small movements resulting in change in focus
- Focus lock by moving to the right side of menu
- Focus region is highlighted and pointer can move up & down selecting within this area
- Moving above or below the region on the right increases the area of the region
- Controls the trade-off between number of items at full size versus those rendered smallest

Demo: http://www.cs.umd.edu/hcil/fisheyeMenu

Apply to Calendars

- DateLens
- Helping people better manage their calendars and appointments on a handheld display
- Uses “fisheye view”

Bederson et al
ACM ToCHI ’04
Particulars

- **Who** – Everyday people
- **Problem** – How to show a potentially large amount of appointment information in a small number of screen pixels (and allow flexibility for different tasks)
- **Data** – Set of appointments

Premise

- At different points in time, you want different perspective on your appts.
  - See how my month looks
  - What’s happening later this week
  - Am I double-booked this afternoon
Technique

- Adopts fisheye view technique
  - Focus item(s) shown in more detail while context still visible, but simplified
- Interaction is key with smooth transitions

Different Perspectives

- Month view
- Zooming to a week
- Zooming to a day
Mélange

- Show 2 foci and the context in-between
- Use 3D like folding a piece of paper

Sigma Lenses

- Use transparency and movement to vary the focus and context
Panacea?

- Are there any disadvantages of focus+context or fisheye techniques?

Disadvantages

- Distortion can be annoying
- Can be very difficult to implement
- Any change in focal point potentially requires recalculation of DoI for all objects and hence re-rendering of all objects -> Expensive!
Nice Review

A Review of Overview + Detail, Zooming, and Focus + Context Interfaces

ANDY CODDRENN
University of Southern
and
AMY HARLSON and BENJAMIN B. BEDERSON
University of California

There are many interaction schemes that allow users to work at, and move between, formal and contextual views of a dataset. We survey and categorize these schemes according to the nature of the relationships used to define their views. Several interaction schemes are based on an overview + detail meta-scheme, in which a compact overview is presented, which highlights or suppresses items within the information space. Categorization of these schemes, and weighted evidence of their success, are presented. The aim is to provide a useful survey of the state-of-the-art in this important and increasingly popular interface strategy, and to identify potentially fruitful areas for further work.

Categories and Subject Descriptions: H.5.2 (Information Interfaces and Presentation): User Interfaces—Graphical user interfaces (GUI)

General Terms: Human Factors

Additional Key Words and Phrases: Information display, information visualization, exchange-oriented, scalable user interfaces, hypermedia, overview

ACM Reference Format:
http://dx.doi.org/10.1145/1408013.1408022

HW 6

• Due Monday
  – Bring 2 hardcopies
Project Advice

• Don’t neglect it now
  – Make consistent progress

Upcoming

• Text & Documents 1
  – Reading:
    Viegas & Wattenberg ’08

• Text & Documents 2
  – Reading:
    Keim & Oelke ’07
References

- Spence and CMS books
- All referred to articles
- S. Meier, Civilization II. MicroProse: 1998
  http://www.civ2.com
- Demonstration maps generated at MapQuest,
  http://www.mapquest.com
- Shneiderman, B. *Designing the User Interface*, 1998