10. Presentation Approaches I
Dealing with the presentation problem

Lecture „Informationsvisualisierung”
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Outline

• Presentation problem

• Zoomable user interfaces (ZUIs)
  – Development history
  – Space-scale diagrams
  – 2.5D
  – Advanced ZUI designs
  – Orientation in ZUIs

• Overview+detail interfaces
  – Abstract overviews
  – Performance issues
  – View coordination
  – View Layout
  – Zoom factors
Presentation Problem

• Very often information spaces have to be displayed, which are significantly larger than the screen size
  – Too many data cases
  – Too many variables

• Potential techniques to maximize the number of information objects that can be displayed
  – Data encodings (see lectures 3 & 4)
  – Interaction and view transformations
  – Hybrid approaches
Presentation Problem

• Most common workaround: scrolling interfaces

• Advantages
  – Many users are familiar with scrollbars
  – Navigation at different speed
  – Thumbs show position and ratio of information space and view size
  – Have been found effective to move small distances

• Disadvantages
  – Only horizontal and vertical shifts
  – Scrollbars usually do not preview the content of the off-screen space
  – Take away screen space
  – Limited to linear navigation
  – Does not scale (search times and interaction sensitivity increase)
Presentation Problem

• Interaction and view transformations
  – Zoomable user interfaces
  – Overview+detail interfaces
  – Focus+context interfaces (upcoming lecture)
Zoomable User Interfaces

• ZUIs aka multiscale interface

• “Navigation in information spaces is best supported by tapping into our natural spatial and geographic ways of thinking” (Perlin & Fox 1993)

• “By moving through space and changing scale the users can get an integrated notion of a very large structure and its contents, and navigate through it in ways effective for their tasks” (Furnas & Bederson 1995)

• Data objects must be organized in space and scale

• Users can manipulate which part of the information space is shown, and at what scale
  – Panning: movement of the viewport over the information space at a constant scale
  – Zooming: altering the scale of the viewport such that it shows a decreasing fraction of the information space with an increasing magnification and vice versa (Spence 2007)

• Due to non-linear navigation ZUIs develop their full potential as the size of the information space grows
Zoomable presentation tool: Prezi.com

- demo: http://prezi.com/b9fk1xyfbber/
Development History

• 1978 - Spatial Data Management System (SDMS) (Donelson 1978)
• Visionary system for visualizing (and zooming) visual database representations
• Relied heavily on custom hardware
  – Rear-projected color television display
  – Octophonic sound system
  – Chair with isometric joysticks, touch-sensitive Tablets and a digital lapboard
Development History

• 1993 - Pad, the first multiscale interface (Perlin & Fox 1993)

• Alternative to the Windows Paradigm
• Visualizes an infinite two dimensional information plane populated with information objects the users can interact with (e.g. text files, personal calendar...)

• Important concepts
  – Portals as customizable views to facilitate navigation
  – Semantic zooming (will be discussed later on)
  – Designed to run on standard hardware

• Screenshot shows quarterly report displayed using Pad along with portals to provide magnified views of details
Development History

- 1994 - Pad++ (Bederson & Hollan 1995), successor of Pad
- Mostly technical enhancements
- Smooth zooming with hundreds of thousands information objects
- Implemented in C++
- Supposed to support platforms ranging from workstations to PDAs and set-top boxes (scalability of ZUIs!)
- Improved platform independency was only achieved by later ZUI toolkits
  - Jazz (2000), Java
  - Piccolo (2004), Java, .NET C#, compact framework
- http://www.cs.umd.edu/hcil/jazz/
Pad++
Space-Scale Diagrams

• Furnas & Bederson 1995
• Diagrams to understand and model multiscale interfaces
• Basic idea
  – 2D image represents information space
  – Construct diagram by creating copies of the 2D image at each possible scale and stacking them up to form an inverted pyramid
• Two axes $u_1$ and $u_2$ represent spatial dimensions of the image
• Vertical $v$ axis represents scale (magnification from 0 to infinity)
Space-Scale Diagrams

- Property I: viewing window
  - Fixed size window which is moved through the 3D space of the diagram
  - Models all possible views, which can be achieved by zoom and pan

- Note: alternative ZUI model could represent space as a fixed 2D plane on which the size of the view window is manipulated

Furnas & Bederson 1995
Space-Scale Diagrams

• Property II
  – A point in the original 2D picture becomes a ray in this space-scale diagram
  – Hence regions of the 2D picture become generalized cones in the diagram

• Property III
  – The only meaningful contents of the space-scale diagram are properties invariant under a shear
  – Do not try to read too much out of the diagram!
Space-Scale Diagrams

- Simplification of the diagram
  - Compress the two spatial dimensions to 1D
  - 3D to 2D diagram
  - Viewing window becomes a 1D slit
  - 6 rays represent six points in the 1D space
  - Example starts with a view of all 6 points and then zooms in on point q
Space-Scale Diagrams

• Study basic pan-zoom trajectories
  • (a) panning: position changes, scale remains constant
  • (b) pure zoom: central position remains constant, scale changes
  • (c) zoom-around: zoom is centered around some fixed point other than the center of the window (in the example point q)
Space-Scale Diagrams

• Joint pan-zoom trajectory
• Use case: automatic navigation to a pre-defined point
• Naive approach: calculate pan and scale distance separately and execute them in parallel - does not work!
• Reason
  – Pan is linear
  – Zoom is logarithmic
• Space-scale diagram shows how the trajectory needs to be modeled
• View monotonically approaches a point in both pan and zoom
• Scale factor $z$ must change hyperbolically with the panning of $x$
Space-Scale Diagrams

- Shortest path between two points
- Not a straight line, i.e. no pure panning!
- Remember: zoom is logarithmic, i.e. provides exponential accelerator for navigating very large spaces
- Arrows of the trajectories represent units of cost
- Diagram shows: to travel a vast distance the following strategy is fastest
  - Zoom out to a scale at which the old and the target position are close together
  - Short pan
  - Zoom back in
Zoom Accelerator

- Power of ten
- 10 million light years from the Earth travel in 40 zoom steps to the protons of an oak leaf in Tallahassee, Florida
More Recent Example: Photosynth

- [http://photosynth.net](http://photosynth.net)

“What if your photo collection was an entry point into the world, like a wormhole that you could jump through and explore...”
More Recent Example: Photosynth
2D, 2.5D and 3D

• ZUIs are NOT 3D but 2.5D applications
• Why not make them 3D?
  – Historical reason: developers of seminal ZUIs wanted to avoid special hardware requirements (by now 3D chips are standard)
  – Simplicity - 3D systems are usually hard to navigate using current 2D display and input device technology
• Still, it is hypothesized that high-quality 3D interfaces may better exploit the human capabilities of spatial cognition and thus can improve user performance
• Mixed empirical results in previous research
2D, 2.5D and 3D

• Example evaluation: physical and virtual systems to retrieve documents in a 2D, a 2.5D, and a 3D setting (Cockburn & McKenzie 2002)
• Results indicate performance advantage for 2D layout to locate images of web pages
• Participants also found the higher dimensional interfaces more cluttered and less efficient
Smooth Zooming

• Older systems only provide a two-level zoom or navigation via coarse jumps

• Smooth continuous zooming
  – More demanding to implement
  – Helps the users to preserve their orientation during navigation
  – Users build a mental map of the information space
  – May improve user satisfaction via hedonic qualities - flying through space metaphor
Semantic Zoom

• Most common is geometric zoom: simply magnifies objects
• Semantic zoom: objects change their appearance as the amount of screen real estate available to them changes
• Semantic zoom provided by a directory browser implemented with Pad++ (www.cs.umd.edu/hcil/pad++)
Goal-Directed Zoom (GDZ)

• Semantic zooming: users zoom in until the target objects shows the desired representation
• Goal-directed zoom: users choose a representation of an object and the change in scale and translation is automatically performed by the system (Woodruff et al. 1998b)
Orientation in ZUIs

• A common problem of ZUIs: the lack of context
• Continuous clipping of orientation cues during zooming
• Amount of context needed is hard to predict
• Depends on variables such as
  – Type and ordering of the information space
  – The users’ familiarity with the information space
  – The task the users want to accomplish
• Example city map navigation: context needed by local citizen versus a first-time visitor
• Most straightforward way to rediscover context in ZUIs: zooming out
  – May also refresh the users’ mental model of the information space
  – But: frequent zoom-outs can be tedious
  – Provide fast and precise interaction design to minimize the required effort
Desert Fog

- Jul & Furnas 1998
- More severe orientation problem for large or infinite multiscale spaces
  - Users zoom into white space between information objects until the viewport goes completely blank
  - Blank screen could mean:
    - There are no more object to be found in that direction -> zoom out
    - There are objects to come, but they are too far away to be seen -> zoom in
- What to do?
Desert Fog

• Add multiscale residues
  – Landmarks for each information object are drawn across scale (think of it as a beacon)
  – Blank screen always means that there are no more objects in that direction
  – Problem: clutter of multiscale residues

• Apply hierarchical clustering to reduce clutter

• Based on spatial proximity

• Problems
  – Where should a landmark be located?
  – Geometric center of a cluster? Meaningful?
  – Most representative object? How to identify?
  – How many levels of the hierarchy should be displayed when? Again, can cause clutter...
Desert Fog

• Concept of critical zones: provide residues of views not objects

• Single critical zone
  – Only views are highlighted, which contain objects
  – Bounding rectangle encloses all contained views
  – Dark rectangle means that the critical zone contains all objects in the world - no sense to zoom out further

• Problem: where to zoom in on inside a critical zone?

• Trial and error strategy
Desert Fog

- Improve navigation aid by showing multiple smaller critical zones
- At the same time limit the number of zones to not cause clutter
- M defines a size, above which a zone is split into smaller zones
Overview+Detail

- Overview+detail (O+d) interfaces are characterized by multi-window layout
  - Detail view presents details
  - Overview window provides overview information of the information space
  - Overview windows are usually also enhanced with visual cues

- O+d interface with field-of-view box give users direct and constant feedback on their position in the information space

- Thus context information is preserved

North & Shneiderman1997
O+D in MS Word

The cars did not separate us.” (P21)

Again this is about travelling together, feeling as "one big group," although being separated. This time the communication is verbal (through the walky-talkies) but still a quite similar reflection on the value of a restricted communication is apparent. Both cars needed to stay close, the group needed to "earn the communication" by paying attention to each other. This seems a crucial aspect to the feeling of belonging.

This participant also described the "dynamics of separation", the moment they heard their friends before they saw them. Another participant shed light on those dynamics:

“I went on a weekend trip together with a couple of friends. We used two cars for the trip. On the highway, we quickly lost sight of our friends in the other car. A couple of hours later, a short time before we had to leave the highway, I suddenly saw the other car again. I was surprised, because I didn’t expect the others to be that close to us. Happily, I took my cell phone and called a friend in the other car. They were also happy to be close to us again.” (P19)

This story further details this play of loosing and finding each other again, and the resulting pleasure. And also this story is about the same experience:

"After a weekend of wedding celebration, the guests all said goodbye to each other and went on their way in their cars – each one heading for very different cities in Germany. None
O + D in Google Maps
Abstract Overviews

• When showing a miniature of a reasonably large information space much detail information may be lost
• Could in some cases be solved by presenting intermediate views, but: display space limitations
• Abstract overviews use encodings to use limited screen space more effectively
• May also contain extra information not present in the detail view
• Example: document overview (Jerding & Stasko 1995)
  – Overview always shows the entire document
  – Intensity scale indicates text density
  – Color denotes sections
Abstract Overviews

We have developed a method for displaying and navigating large and complex information spaces using the multiple view technique. This work is derived from our implementation of the message trace visualization. In their work, Frewen, Jaccard, and Scharen propose three important considerations in the design of multiple-view browsers: window placement strategy, view coordination, and the global view itself. The first section describes the design of the message view and its navigation mechanisms. We call our views of large information spaces "Information Mural", and describe them in Section 3. In Section 4 we discuss several application areas where the information murals are useful, and compare our methods with related work in those areas.

As mentioned in the last section, one area of our work involves visualizing the execution of object-oriented programs. As a complement to the integrated testing environment, we are designing a display of the messages exchanged between objects during the execution of a C++ program. This section describes the "execution mural", focusing specifically on the visual mechanisms used to provide navigation capabilities. While the current state of the design does not contain all the functionality envisioned for this view, it does provide an effective demonstration of our methods. The techniques discussed in this section will be generalized to other information spaces in Section 3.
Interface Performance

• Task-completion time
  – Navigation on the overview may significantly improve the interface performance
  – E.g. users can directly navigate to locations that are currently not visible on the detail view
  – Drawback: multiple views require time-consuming visual switching between views

• User study by Hornbaek et al. 2002
• 32 participants, counterbalanced within-subjects design
• Browsing and navigation tasks on two maps
• Two semantic ZUIs, one with and one without overview
• Participants were faster with the detail-only interface
• 80% preferred the overview-enhanced interface

Hornbaek et al. 2002
View Coordination

• Most simple o+d: overview shows a static image of the information space
  – Users are forced to compare the visual cues in the detail view with the cues in the overview
  – For reasonably large and complex information spaces, this approach is hardly usable

• Dynamic overviews
  – Visual cues such as a field-of-view box aid orientation
  – Implies coordination of views

• Coordination (also termed tight coupling)
  – Unidirectional: only one view is interactive
  – Bidirectional: supports user input in both views

• Study by North&Shneiderman2000: coordinated views were found to be 30% to 50% faster than a detail-only interface and a o+d interface with two independent views
View Layout

• Basic side-by-side layout of views require that the available display space is partitioned between the views

• Problem: for both views the usability increases with a growing size

• No general solution for the space tradeoff

• Layout of the views is task-dependent (Plaisant 1995)
  – Open-ended exploration or drawing tasks require a larger detail view
  – Monitoring tasks require a larger overview
Alternative View Layouts

• Overlapping views
  – Overview overlaps with the detail view (e.g. Acrobat overview)
  – Users can drag and scale the overview view as desired
  – Problem: managing windows is time-consuming and adds extra complexity to the interface

• Automatic overviews
  – System decides when to (temporarily) display an overview
  – How to predict the need for an overview?
  – E.g. extensive zooming and panning on the detail view
  – Malfunction can be highly annoying

• Transparent overviews
  – Can be applied to both overlapping and automatic overviews
  – Problems: increased visual clutter and deteriorated readability of both detail view and overview
Zoom Factors

• Zoom factor: level of magnification between detail view and overview

• Should be
  – Less than 20 (Plaisant 1995)
  – Between 3 and 30 (Shneiderman & Plaisant 2005)

• Larger zoom factors may require intermediate views