

# Navigation and Zooming

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# Overview

- Navigation Patterns and Usability of Zoomable User Interfaces with and without an Overview
- Domain Name Based Visualization of Web Histories in a Zoomable User Interface
- Does Zooming Improve Image Browsing?
- Zooming and Tunneling in Tioga: Supporting Navigation in Multidimensional Space
- Constant Information Density in Zoomable Interfaces

# Navigation Patterns and Usability of Zoomable User Interfaces with and without an Overview

Hornbaek, K., Bederson, B., and Plaisant, C.

# Definitions and Problems

- Definition of a zoomable interface is based on two characteristics:
  - 1) Information objects are organized in space and scale
  - 2) Users interact directly with the information space, mainly through panning and zooming
- Zoomable interfaces come in two flavors:
  - Geometric zooming where the zoom scale is linear with the zoom multiplier
  - Semantic zooming where objects may change shape at different zoom levels
- Few empirical studies have thoroughly investigated the usability of zoomable user interface
- The results of current studies have been inconclusive

# Relevant previous work

- Overview and detail has been found useful in many previous studies
- Empirical investigations of zoomable interfaces have been inconclusive to date; generally the experimental results were mixed

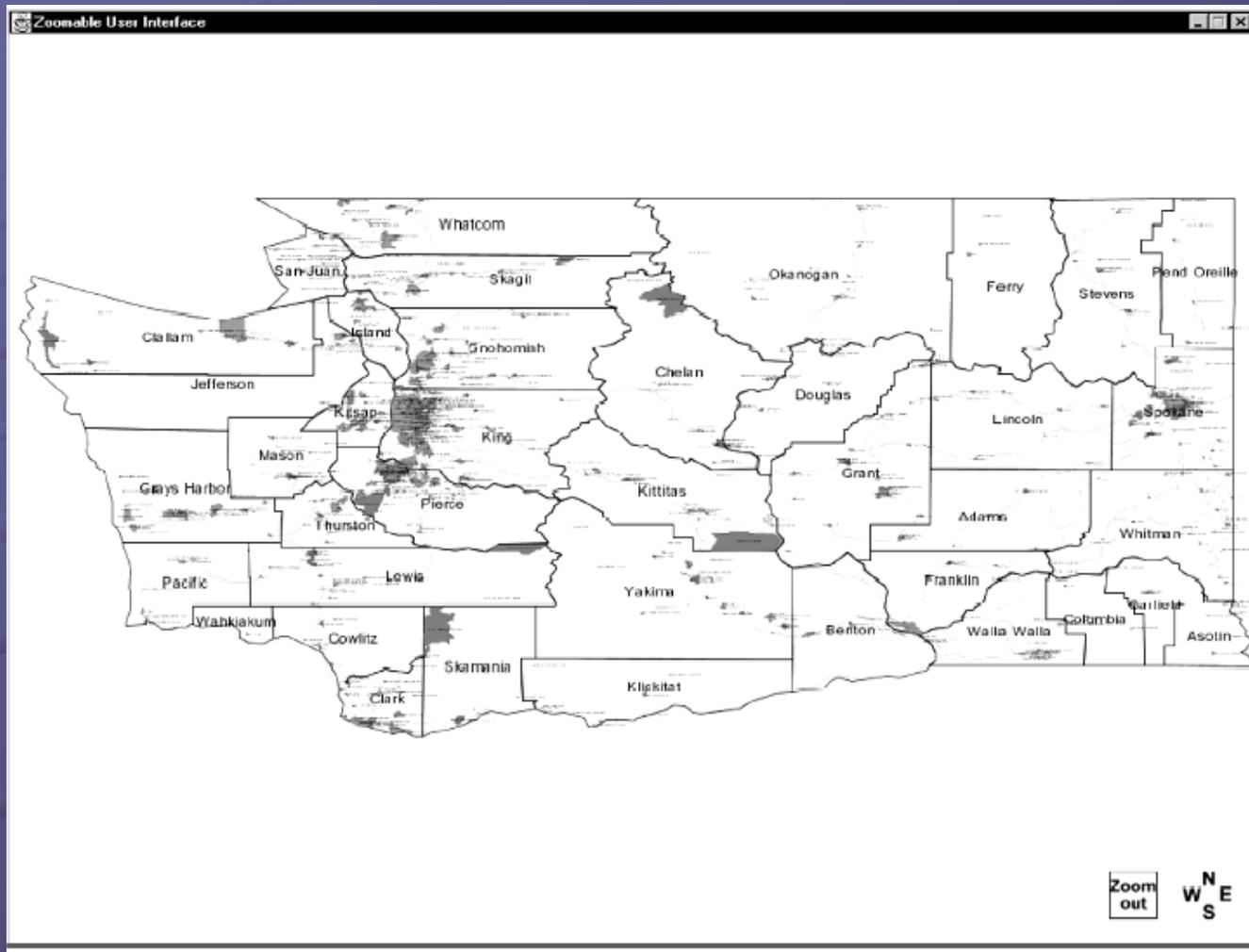
# Proposed Solution

- This article presents an empirical analysis of zoomable user interfaces with and without an overview:
  - Whether the overview affects usability
  - How the overview influences the way users navigate information spaces
  - How different organizations of information spaces may influence navigation patterns and usability

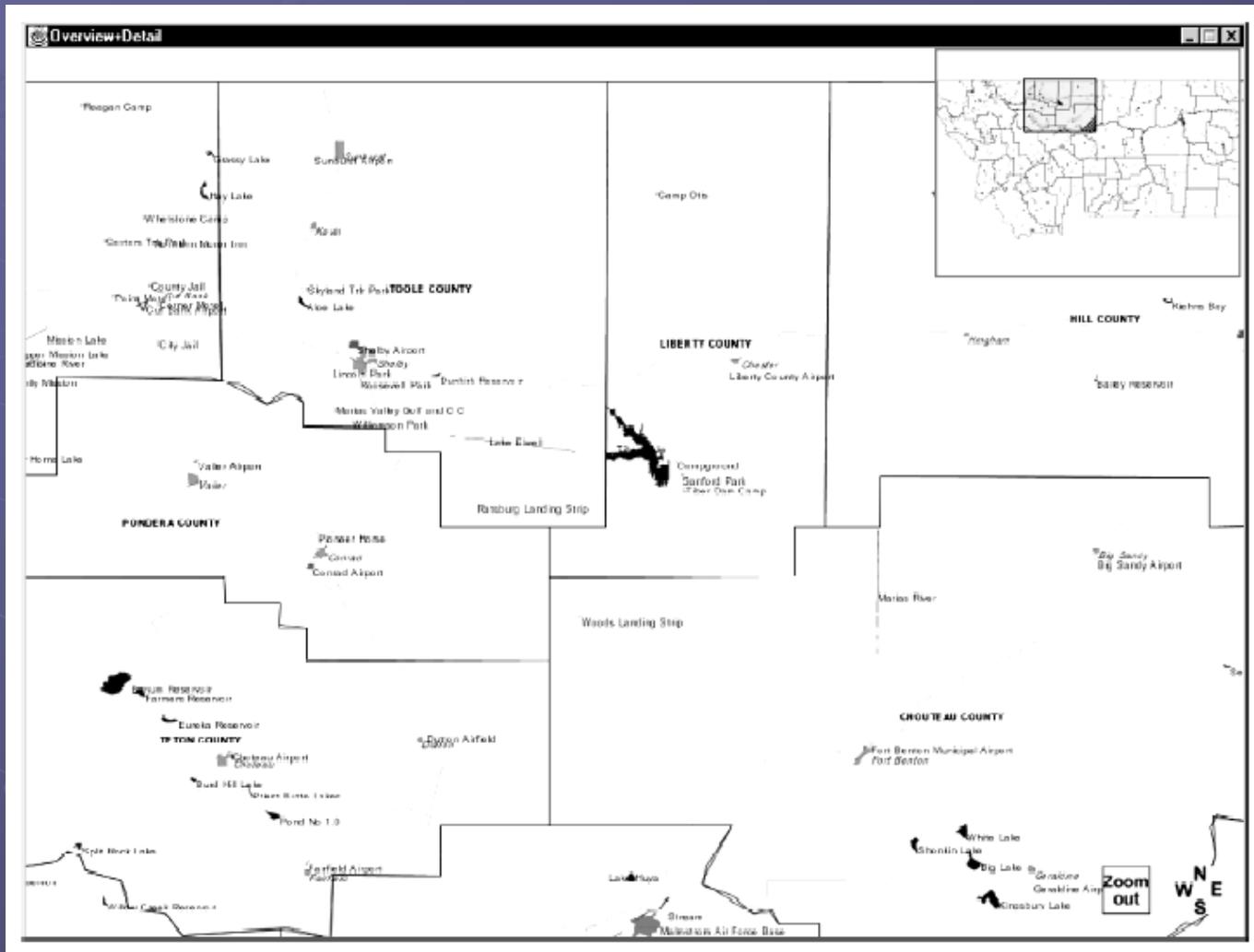
# The experiment

- Users were provided an 'overview interface' and a 'no overview' interface to solve 10 tasks on each of two differently organized maps
- Three hypothesis for the experiment:
  - 1) Recall of objects on the map would be better with the no-overview interface
  - 2) Users would prefer the overview interface
  - 3) The overview interface would be faster for tasks requiring the comparison of information objects and scanning large areas

# No Overview



# With Overview



# Maps

- Maps were selected as the experiment subject matter
- The information contained in the map of Washington and Montana differed in their layout:
  - The map of Washington showed map objects at three scales: county level, city level and landmark level
  - Montana displayed all 806 labels at scale 7
- The objective of differentiating these two maps was to represent information spaces that present the user with richer navigation cues (the Washington map), whereas the Montana map was intended to show a flat organization with weak navigation cues.

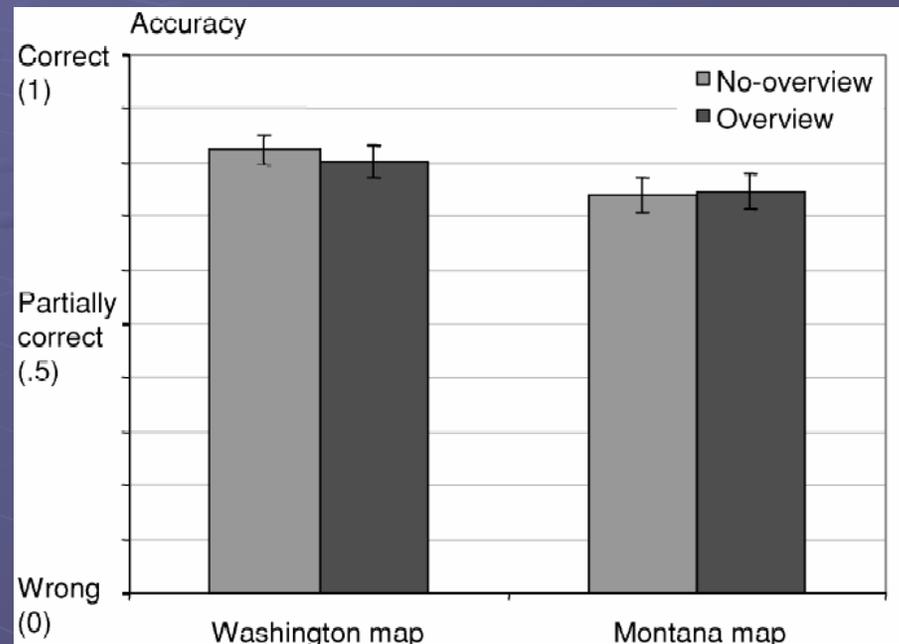
# Tasks

- 10 tasks created for each map
- 5 navigation tasks
- 5 browsing tasks
- The solutions to the tasks were evenly distributed across the map, and answers were located at different scales.
- Users were also given 2 recall tasks to test their memory.

# Experimental Design

- The experiment consisted of two parts:
  - Using one map with the overview interface
  - Using the other map without the overview interface
- Within each of these four possible combinations four permutations of task types were also randomly assigned. Each of the resulting 16 groups contained 2 subjects.
- Key dependent variables included:
  - Accuracy of questions answered
  - Task completion time
  - Preference
  - Navigation activities
- All interactions were logged and the number of pan/zoom actions and distances were measured.

# Accuracy Results

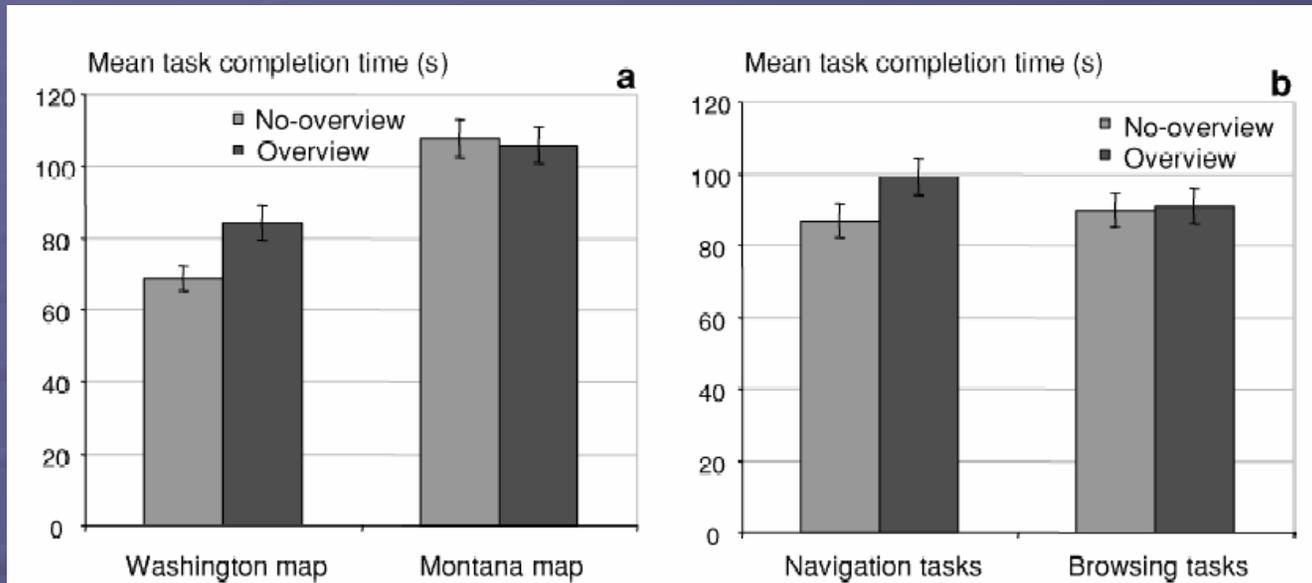


- No significant difference in accuracy existed between interfaces!
- A significant difference did exist between the maps; the Washington map answers were more accurate.
- Users with the overview interface did better at the recall task with the Montana map; the no-overview interface yielded the opposite pattern.

# Survey Results

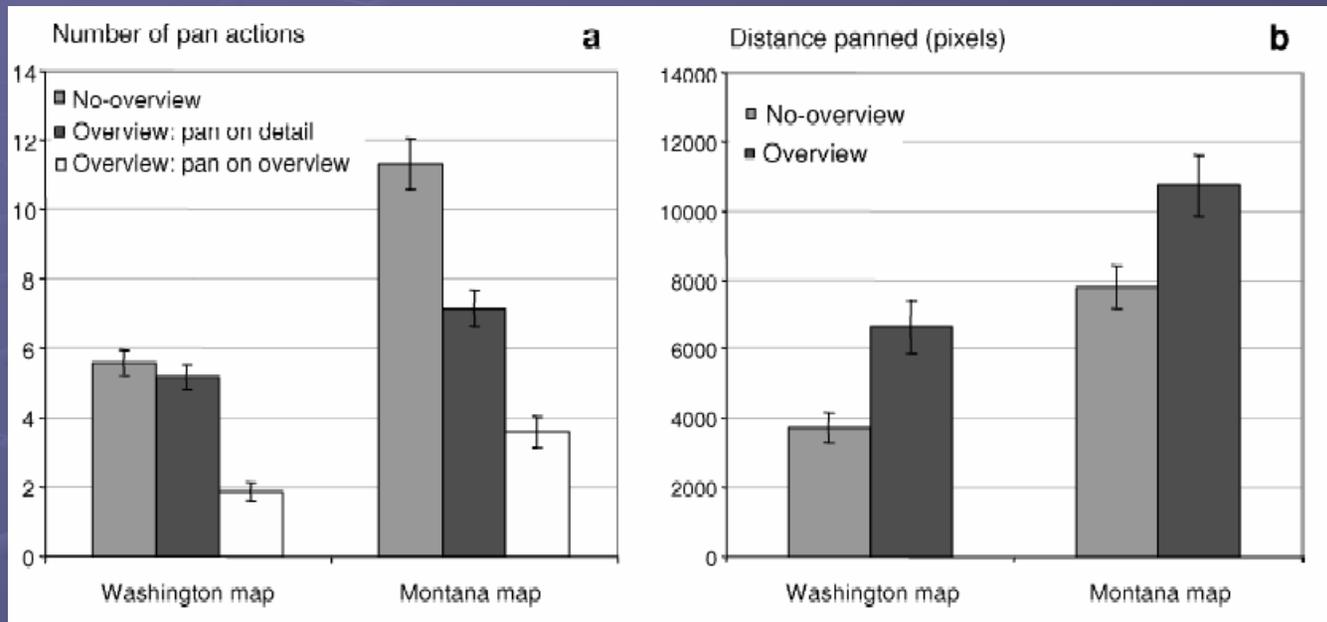
- 26 subjects preferred the overview interface, 6 preferred the no-overview
- Preferences were stated with the following reasons:
  - Overview window gave information about the current position
  - It was easier to navigate using the overview box and using the detail view for the answers
  - The overview was helpful when scanning a large area
  - The overview was useful for zooming
  - The overview supported comparing objects
- Subjects who preferred no-overview said the following:
  - Locating objects felt faster
  - Overview window 'got in the way'

# Navigation Speed Results



- The Washington map was significantly faster than the Montana map.
- A significant interaction was discovered between interface and map; tasks solved with the no-overview interface on the Washington map were solved 22% faster. This contradicts the third hypothesis!
- Tasks on the Montana map were solved with comparable mean times.
- On the Washington map, four of five browsing tasks were completed faster with the no-overview interface.

# Navigation Patterns



- Users with the overview panned a 51% further overall distance than those without.
- Tasks where the overview was actively used were 20% slower; increasing the number of transitions between overview and detail resulted in slower completion times.

# Discussion

- The findings that users who actively used the overview were slower contradicts previous studies.
  - No support was found for the third hypothesis; in fact there was some evidence to the contrary that the no-overview interface can be significantly faster
- Speculation on why the overview interface was slower:
  - The overview might be visually distracting
  - Switching between overview and detail view may have taken more mental effort and mouse movement
  - Navigation on the overview was 'coarse' and could be difficult at low zoom factors
  - Possibly users never became competent in using the added complexity of the overview.
- There seems to be a trade off between the two interfaces, with no-overview interface being faster for the Washington map and the overview interface providing higher satisfaction.

# Recommendations and Conclusions

## ● Recommendations:

- Designers need to consider the trade off between satisfaction and task completion time
- Interfaces with an overview should use consistent navigation cues between the two interfaces; all zoom and pan actions should be the same
- Overviews should be at least 1/16th the size of the detail area

## ● Conclusions:

- Results suggest a trade off
- Subjects were significantly faster without the overview when using one of the two maps
- Subjects were significantly faster with the map that had more levels of detail

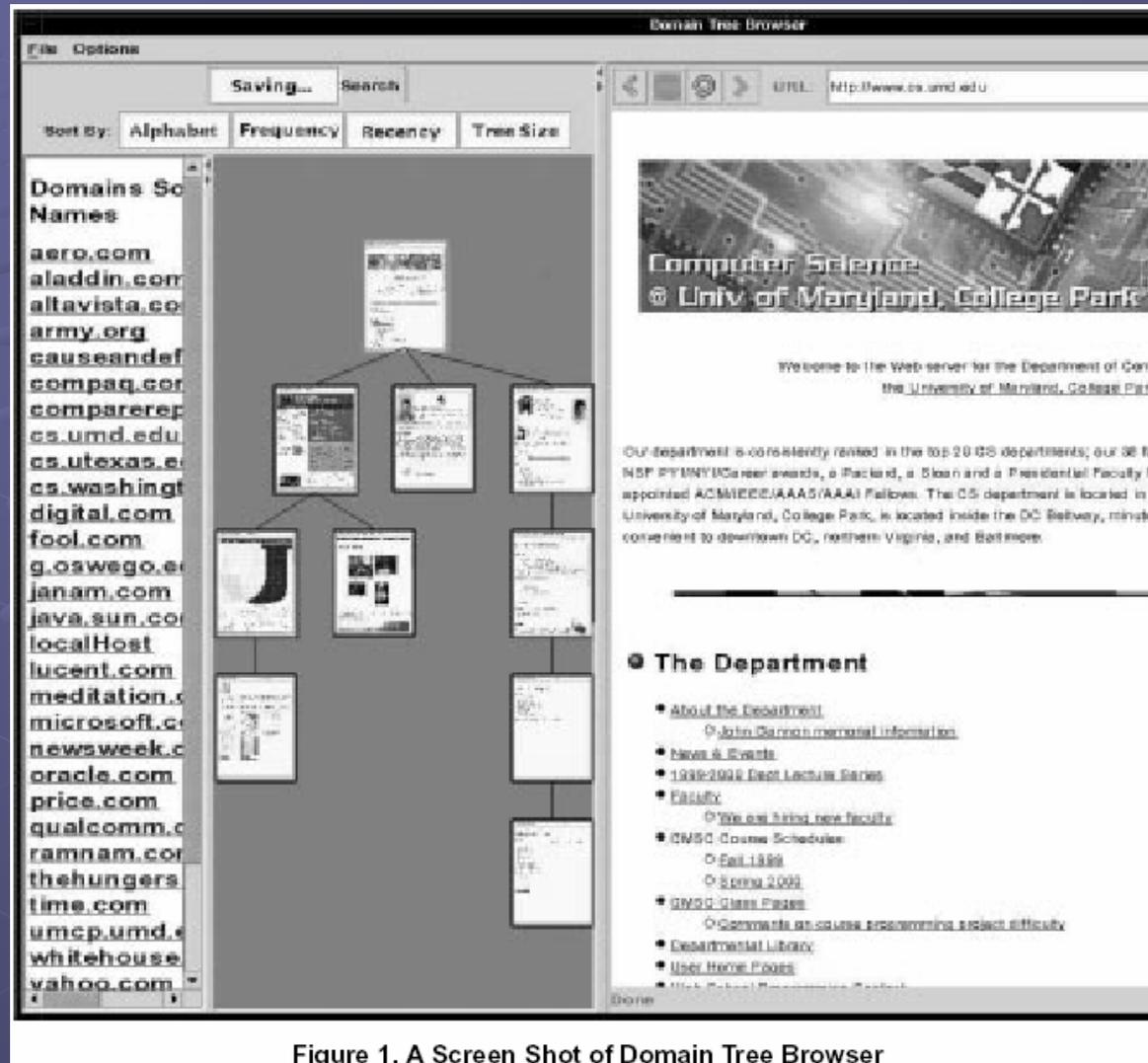
# Domain Name Based Visualization of Web Histories in a Zoomable User Interface

Gandhi, R., Kumar, G., Bederson, B., and  
Shneiderman, B.

# The Problem

- Users of the web often get "lost" in their browsing and have a hard time finding their way back to pages previously visited
- Navigating is hard for users:
  - 13.4% of subjects report not being able to find pages recently visited
  - They claim 42% are visited via the back button; this seems like a high number.
  - Whenever a branch is followed, a significant portion of history is lost.
- History list is textual and may lack cues required to find a given page
- The difficulty in revisiting previously viewed pages may discourage exploratory behavior; although its not entirely clear why this might be the case
- Overall: the problems they have identified are indeed problems, but seem to be somewhat overstated!

# Solution overview



# Implementation and Shortcomings

## ● Implementation

- Implementation does not attempt to recognize if two URL's reference the same document
- Thumbnails are generated by continuous screen grabs until the stop button is pressed or the rendering is complete

## ● Current shortcomings

- Users may want to delete specific nodes but currently cannot
- Because the trees are broken up parent/child relationships between nodes in the tree may not actually exist
- Users may want to relocate sub-trees
- Being able to add annotations and save histories to disk would be useful

# User Testing

- A modified version of DTB which presented only a single tree history that modeled PadPrints called STB was created. The idea was to compare using a single tree history browser vs. multiple trees, not to compare against 'flat' histories.
- Users took less time with DTB browser to revisit already visited pages
- Mean time to answer a question was shorter with DTB
- Users identified a need to search for a specific node within a tree; not possible with the current implementation

# Criticisms

- Quantitative numbers were discarded because they weren't statistically significant!
- Subjects were only given the search functionality for DTB but not for STB
- Providing basic node search functionality seems like a trivial but important enhancement

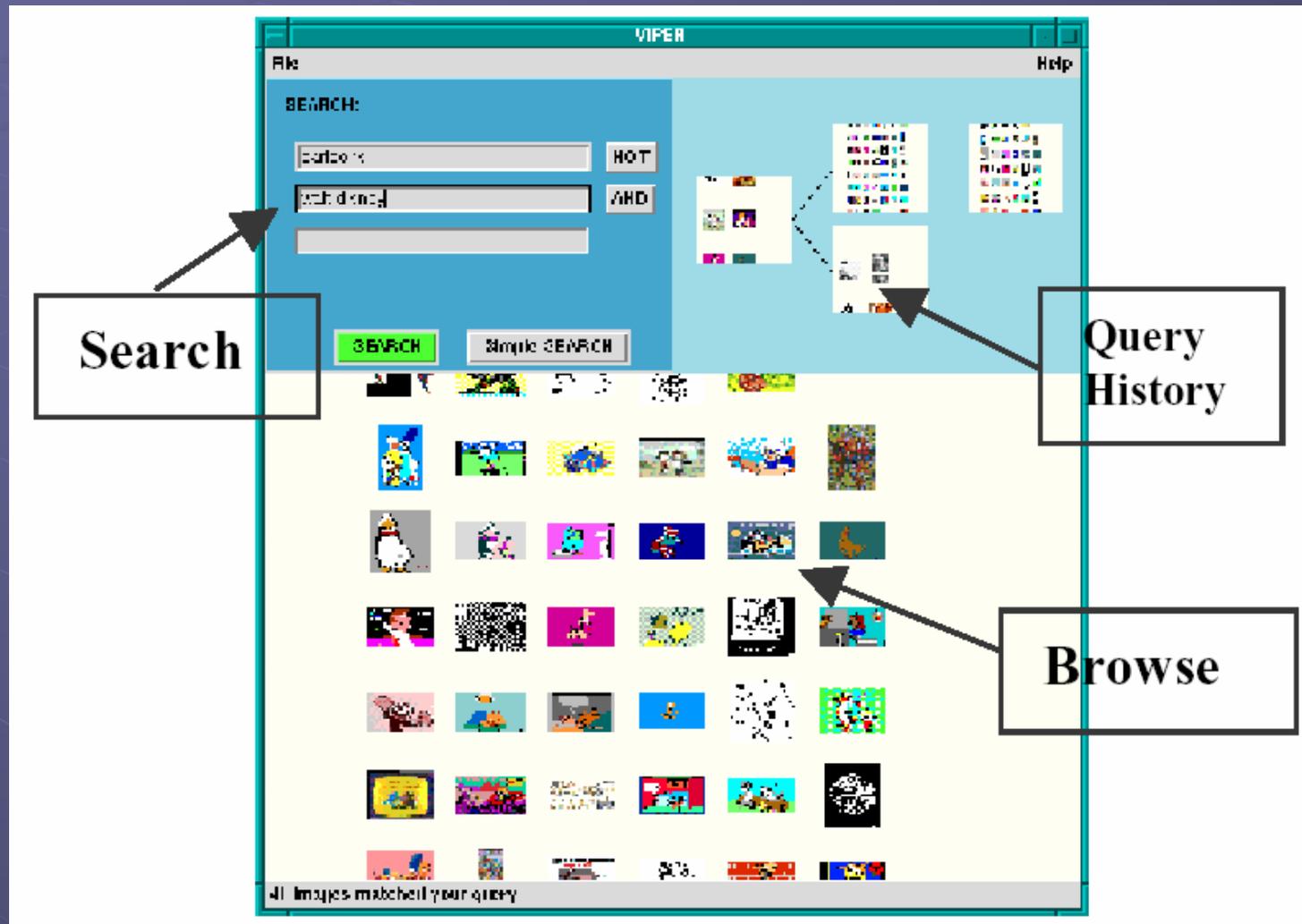
# Does Zooming Improve Image Browsing?

Combs, T., and Bederson, B.

# The Problem

- Amount of stored graphical information has skyrocketed creating new requirements:
  - The ability to store and manipulate images is more important
  - There is a need provide sophisticated ways to retrieve and browse images
- Screen real-estate is always valuable; the authors believe 3D and zooming make better use of screen space than scrolling

# The Solution: ZIB



# Experiment Introduction

- Experiment focused on the browsing task using four browsers:
  - ThumbsPlus is an image browser which allows users to view thumbnails of images:
  - Simple Landscape is a 3D image scene that shows billboarded thumbnails:
    - Users 'walk' or 'fly' through landscape with billboard images, clicking on an image causes it to appear in another window
  - PhotoGoRound provides a rotating 'rack' of images similar to postcard racks or rotating jewelry displays:
    - The entire scene can be rotated using the upper or lower disk or can automatically spin
    - Photos were billboarded so they always face the user
  - Final browser was ZIB as previously described

# The Experiment

- The null hypothesis was initially adopted
- Each subject was asked to browse through a set of images until they located the target image.
- Subjects received training on the first image browser they were to use.
- Two experiments were conducted:
  - Experiment 1 was between subjects. Each participant was randomly assigned one of the four browsers and time to locate an image in various images sets ranging to 225 images was measured
  - Experiment 2 involved users trying all 'secondary' browsers, providing subjective satisfaction ratings as well as number of errors to make the correct selection in the secondary browsers

# Results and Conclusions

## ● Results:

- ZIB was significantly faster than both 3D browsers, but not ThumbsPlus
- ZIB was not significantly preferred over ThumbsPlus
- ZIB and ThumbsPlus had the least number of errors
- Roughly half the subjects never zoomed using ZIB even when given the 225 image experiment set

## ● Conclusions:

- Possibly a larger image set should have been included to force users to use the zoom functionality
- Designers should use a 2D grid or zoomable browser if number of errors is important
- Both 3D approaches suffered heavily with large data sets
- The existence of an optimal number of images for a given display space is not answered

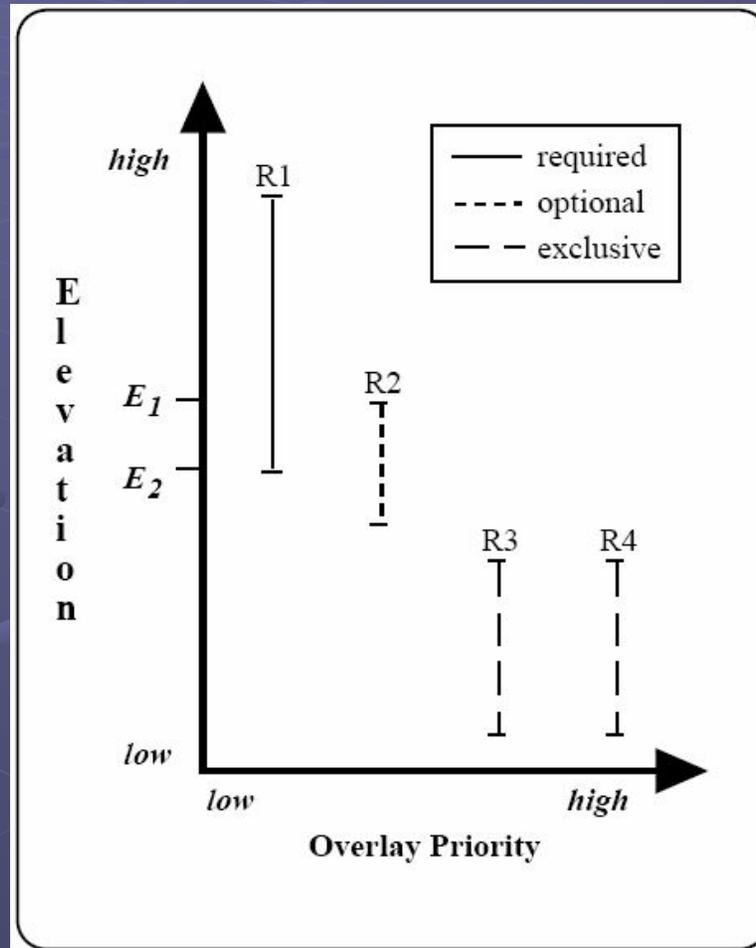
# Zooming and Tunneling in Tioga: Supporting Navigation in Multidimensional Space.

Woodruff, A., Wisnovsky, P., Taylor, C.,  
Stonebraker, M., Paxson, C., Chen, J., and Aiken,  
A.

# Tioga Background

- Boxes represent user defined database queries or browsers, edges represent flow of data
- Boxes are interactively connected by the users to create 'recipes'
- Browsers are attached to recipes wherever data needs to be visualized providing a 'flight simulator' interface

# Elevation Map



# Enhanced Zooming Extension

- Semantic zooming is introduced; data should have different representations at different distances in multidimensional space
- The elevation map relates the recipes to each other by specifying which recipes are valid at what distance from a given object
- Constraints can be placed on each recipe in the elevation map allowing it to be required, optional or exclusive
- Enhancements to semantic zoom allow for 'tunneling' through a wormhole
- Wormholes can invoke new applications to handle the specifics of the new multidimensional space, while still allowing the user to 'back out' of them

# Browser nesting

- Browsers can be placed one inside of the other, an example of which might be a magnifying glass browser inside of a browser showing the state of California
- These browsers share a window but contain separate controls and may have one of two relationships:
  - Independent browsers do not affect one another when they move in a zoom or pan operation; this behavior is most appropriate when they are displaying independent objects
  - Alternately browsers can be slaved to a master browser allowing the slave to be moved proportionally with the master browser
- Inner browsers may themselves be outer browsers allowing for theoretically infinite recursion; practical/useful depth is not discussed

# Constant Information Density in Zoomable Interfaces

Woodruff, A. , Landay, J., and Stonebraker, M.

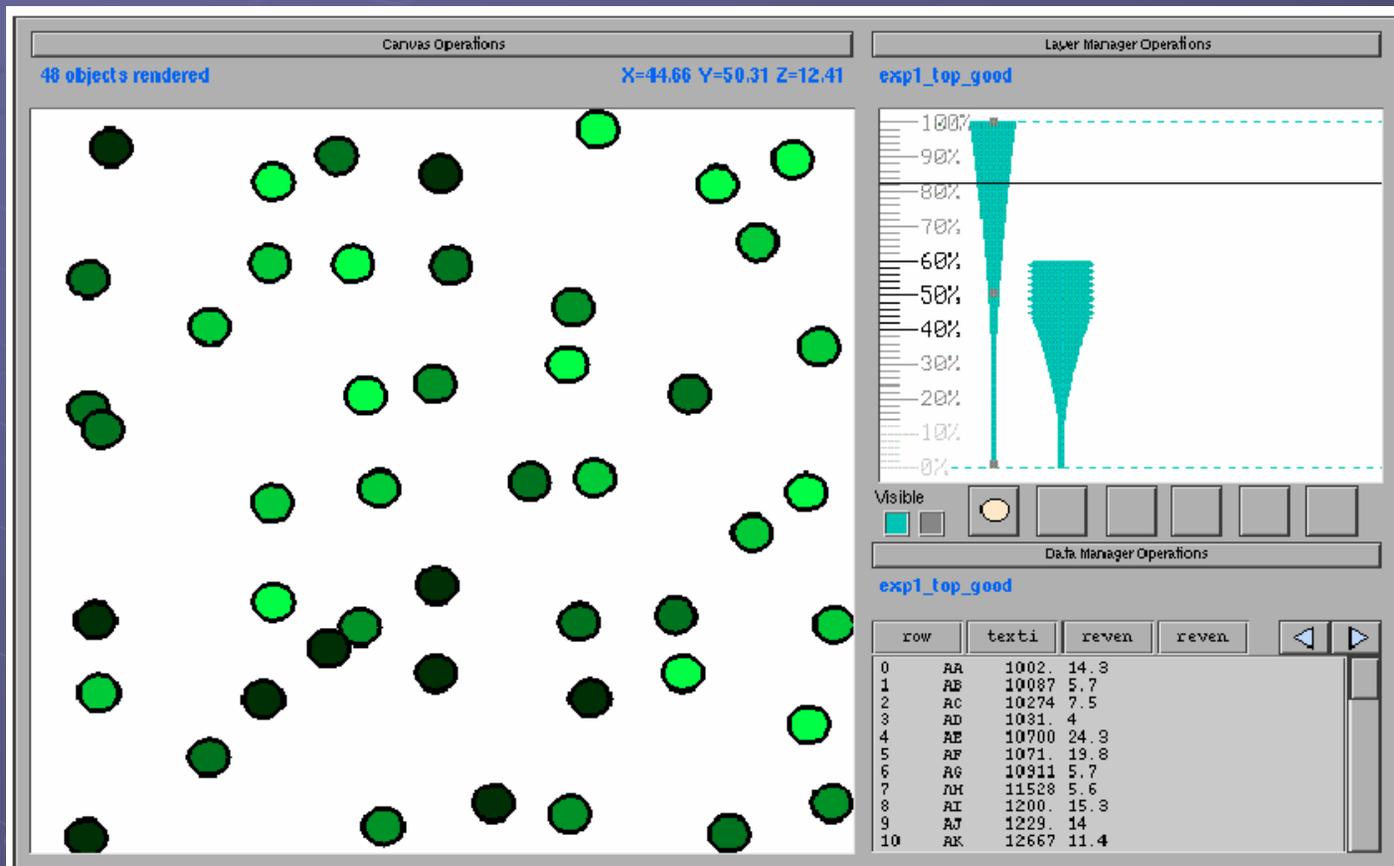
# The Problem

- Clutter can have negative effects, decreased performance and diminished visual appeal
- People locate information faster when less is presented to them: “less is more”
- The current DataSplash system can display a different number of objects depending on zoom resulting in varied information density which may be cluttered
  - The only way to resolve this problem in DataSplash is to zoom in and out to find a 'comfortable' level using a trial and error approach
- The guiding principal from cartographic literature is that the number of objects per display unit should be constant!

# Solution

- A DataSplash extension provides users feedback about the density of information as they construct the view. Another extension provides suggested improvements to the visualization.
- They have modified two of the display objects in the original layer manager to make their properties give the user an additional indication of information density:
  - The width of each layer bar now reflects the density of the corresponding layer at the given elevation. The scale of the width of the layer bar is based on maximum bar width, so maximum width would have the maximum cumulative density.
  - Cumulative density is now displayed via tick marks on the left side of the layer manager, using color coding to indicate too low density, correct density, or excessive density. Density is measured by counting the number of objects visible in the display at a given elevation.

# Design



**Figure 3: A visualization of selected companies from the Fortune 500 and Global 500 lists.**

# Interaction

- The system currently supports only two metrics:
  - Number of objects
  - Number of vertices
- Another extension provides automated support for 'suggestions' to improve density consistency:
  - As users graphically adjust the width of a layer the underlying system would apply modification functions to generate the necessary transformations to achieve the specified density. The selected transformations would be presented as portals and the user could evaluate each portal to decide which was 'best'.
  - Possible modifications are presented in the table on the following slide

# Modifications

- For each modification function on the table an example of a density metric affected by the modification is presented along with the visualization resulting from the application of the modification.
- The first three functions apply to the data, the remaining four affect the graphical representation of the object.
- Functions may decrease or increase density depending on the metric used in some cases.

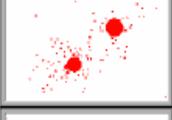
Original visualization	
<b>Select</b> <i>Restrict to cities with population &gt; n</i> Decreases number of objects	
<b>Aggregate</b> <i>Aggregate cities by state</i> Decreases number of objects	
<b>Reclassify</b> <i>Assign to population brackets</i> Decreases number of sizes	
<b>Change shape</b> <i>Change circles to triangles</i> Decreases amount of ink	
<b>Change size</b> <i>Scale circle radius</i> Decreases amount of ink	
<b>Remove attribute association</b> <i>Disassociate size from population</i> Decreases data density	
<b>Change color</b> <i>Change color from gray to black</i> Decreases number of colors	

Table 1: Modification functions to decrease density.

# User Study

- The study was performed on user navigation in applications with and without constant information density.
- The objective was not to examine density metrics and appropriate values, but to examine user response to density variance.
- Seventy nine participants took part in an Internet study. The task was to locate the company with the highest revenue growth based on data from the fortune 500.
- Overall users appeared to prefer layers with lower information density, pan operations tended to happen at highest or lowest elevations.
- Problems:
  - The speed of the applet could not be controlled resulting in concerns subjects may have avoided dense layers due to performance problems.
  - Demographic distribution of subjects could not be assured due to the internet nature of the study.

# Conclusions

- The literature suggests providing constant information density is important.
- The user study conducted here doesn't provide a great deal of information about the particular contributions their project has made.
- Further automation of the 'suggestion' tool may be helpful; particularly if it can cope with multiple density metrics.
- Performance of the application might be improved by removing detail when panning operations are taking place mitigating some of the performance concerns.

# Review

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# Bibliography

- Combs, T., and Bederson, B., "Does zooming improve image browsing?," Proceedings of the fourth ACM conference on Digital libraries, pages 130-137, 1999.
- Gandhi, R., Kumar, G., Bederson, B., and Shneiderman, B., "Domain Name Based Visualization of Web Histories in a Zoomable User Interface," Proceedings of the Second International Workshop on Web-based Information Visualization, pages 591-598, 2000.
- Hornbaek, K., Bederson, B., and Plaisant, C., "Navigation Patterns and Usability of Zoomable User Interfaces with and without an Overview," ACM Transactions on Computer-Human Interaction, Vol. 9, No. 4, pages 362-389, 2002.
- Woodruff, A., Landay, J., and Stonebraker, M., "Constant Information Density in Zoomable Interfaces," Proceedings of AVI '98, pages 57-65, 1998.
- Woodruff, A., Wisnovsky, P., Taylor, C., Stonebraker, M., Paxson, C., Chen, J., and Aiken, A., "Zooming and Tunneling in Tioga: Supporting Navigation in Multidimensional Space," Proceedings of the IEEE Symposium on Visual Languages, 1994.