Interaction

COMP8503
Visualization & Visual Analytics

Uses of Interaction

- **Interaction** is useful for integrating human in the data exploration process and applying its perceptual abilities
  - For modifying data transformation (filtering)
  - For modifying visual mappings
  - For modifying view transformation (navigation)
  - For human-information discourse
    - Comparing and categorizing data
    - Extracting and recombining data
    - Creating and testing hypotheses
    - Annotating data

Levels of Interaction

- Card et al.[1999]
  - ~100 msecs: needed for producing the perception of smooth animation (~10 frames/sec) (cf. min human motor response time ~200 msecs)
  - ~1 sec: needed for responding to simple user actions (e.g., clicking a web link)
  - ~10 secs: users expect more complex activities to complete (e.g., a complex search)
  - ~100 secs: in which higher level reasoning takes place

A Scenario

- Imagine you are viewing a lengthy document and only scrolling and panning are allowed
- Problems?
  - Discontinuity between the text displayed at different times
  - User must mentally assimilate the overall document
  - Can be a cognitive and mechanical burden for the user

The Information Seeking Mantra

- *Overview first, zoom and filter, and then details-on-demand* (Shneiderman 1996)
- Identifies patterns in the overview
- Focuses on one or more patterns
- Drills down to access the details
- It is important to keep the overview visualization while focusing on the subset using another visualization technique

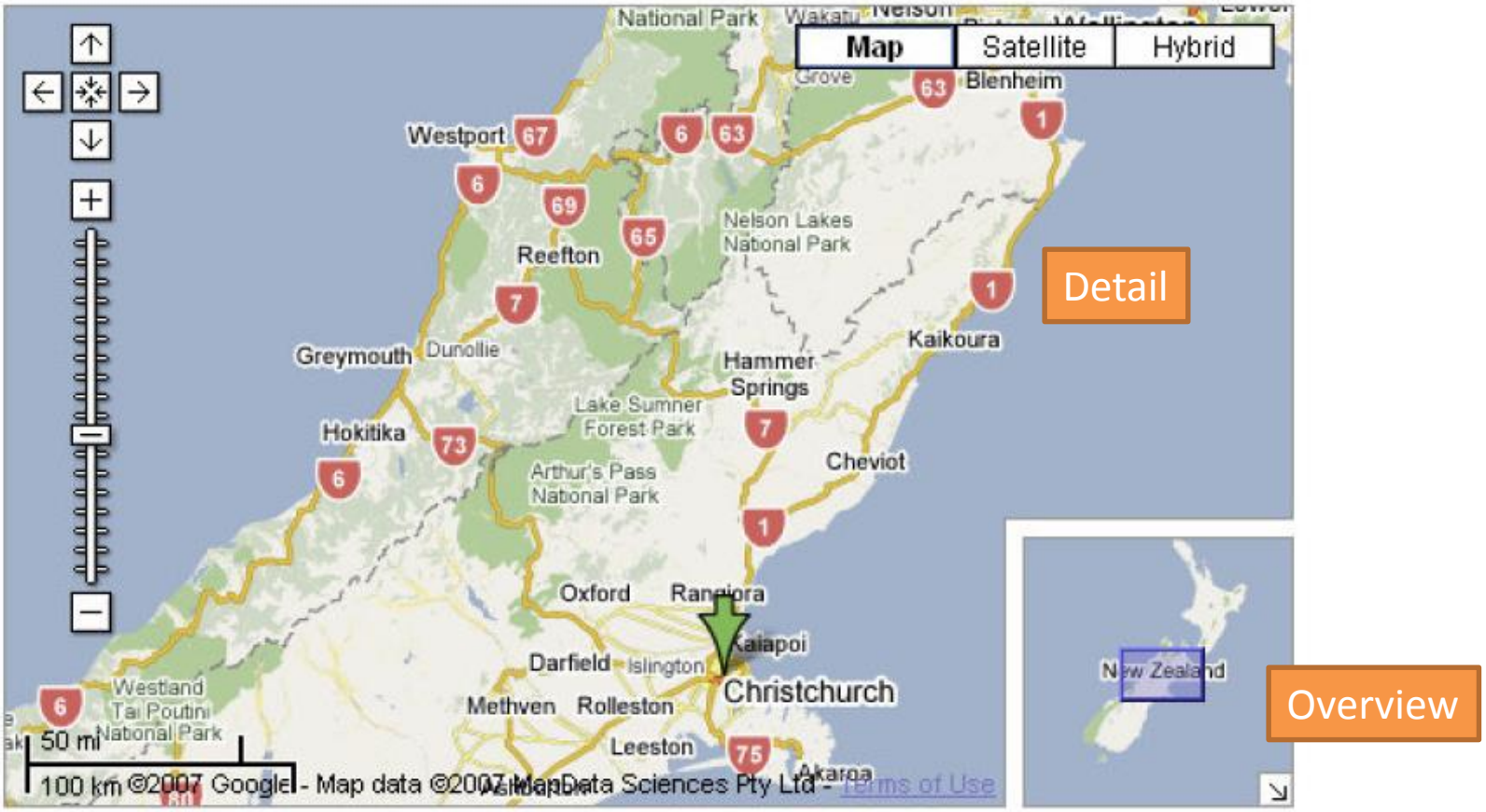
Interaction & Distortion Techniques

- Interaction:
  - Allows the user to interact with the visualization and dynamically change the visualizations according to the exploration objectives (as compared to static visualization on paper)
  - Enables relating and combining multiple independent visualizations
- Distortion:
  - Allows focusing on details while preserving an overview of the data
  - Shows portions of the data with a high level of detail, while others are shown in a lower level of detail

Interaction & Distortion Techniques

- **overview+detail**: spatial separation
- **zooming**: temporal separation
- **focus+context**: seamless focus in context
- **linking and brushing**: integrate data in different views

Overview + Detail



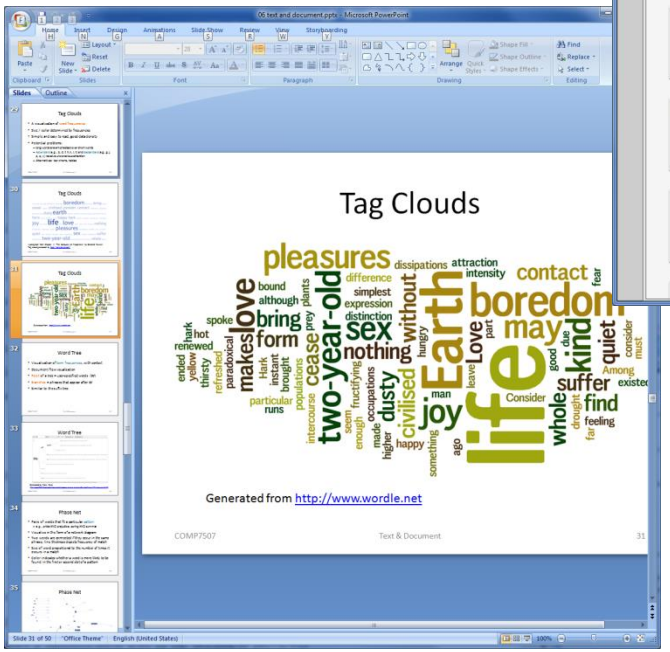
[Cockburn et al. 2002]

Overview + Detail

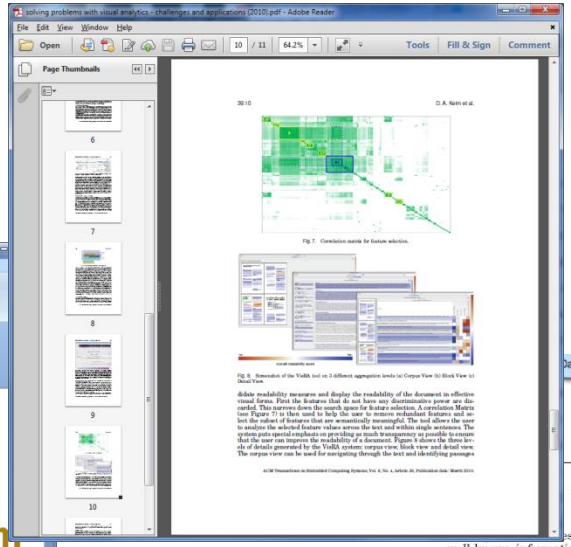
- Simultaneous display of an overview and a detailed view of data, but each in distinct display space.
- User interacts with the two views separately
- May specify a region in an overview and the details are shown in the detailed view.
- Issue: How should the overview and detailed views be coupled?
- Common practice: Asymmetric synchronization
  - Changes in the detailed view shows immediately in the overview
  - Exploration in the overview does not change the detail view

Overview + Detail

- More examples



Microsoft PowerPoint



Adobe Acrobat

Magnifier on Windows

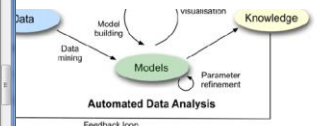


Fig. 1. Visual Analytics Process [D. A. Keim 2010].

well-known *information overload problem.*

As a young upspring science field that aims at tackling the information overload problem, visual analytics *combines automated data analysis with interactive visualizations for an effective understanding, reasoning, and decision making on the basis of*

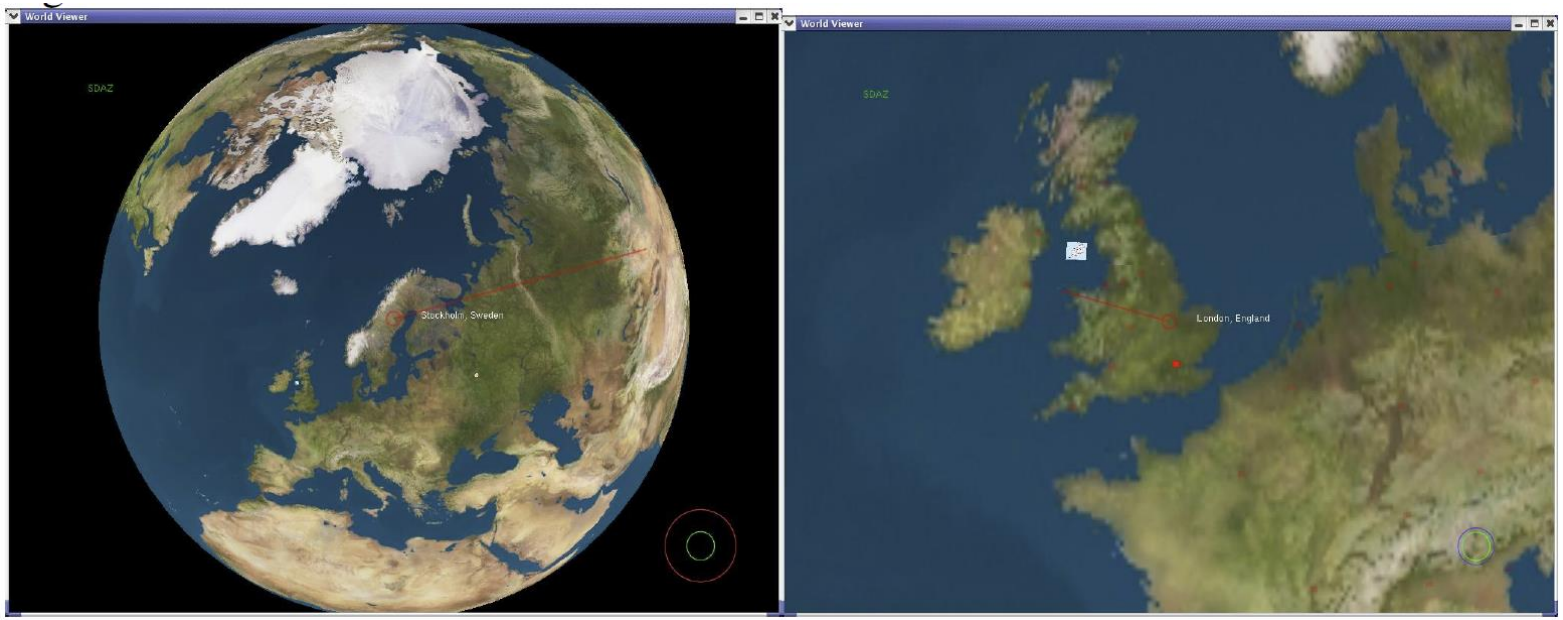
of visual analytics. First of all, heterogenec
integrated. Automated analysis techniques c
he original data. These models can be visual
ition to checking the models, visual represer
ing a variety of interactive visualization tec
fic data type, structure, and dimensionality
e can be gained from visualization, automat
etween visualization, models and the hum
knowledge of insightful analysis in the syst
ter and better conclusions in the future. Ar
user interaction: analysts should be able t

exemplify them with some real world applications. In section 2, we briefly introduce related work in defining the concept, scope and paradigm of visual analytics. In section 3, we detail the challenges of visual analytics in the technical aspects of the field.

ACM Transactions on Embedded Computing Systems, Vol. 9, No. 4, Article 39, Publication date: March 2010.

Zooming

- Use a single window to show focused and contextual views with temporal separation
- Magnify (zoom in to focus) and Demagnify (zoom out for context)



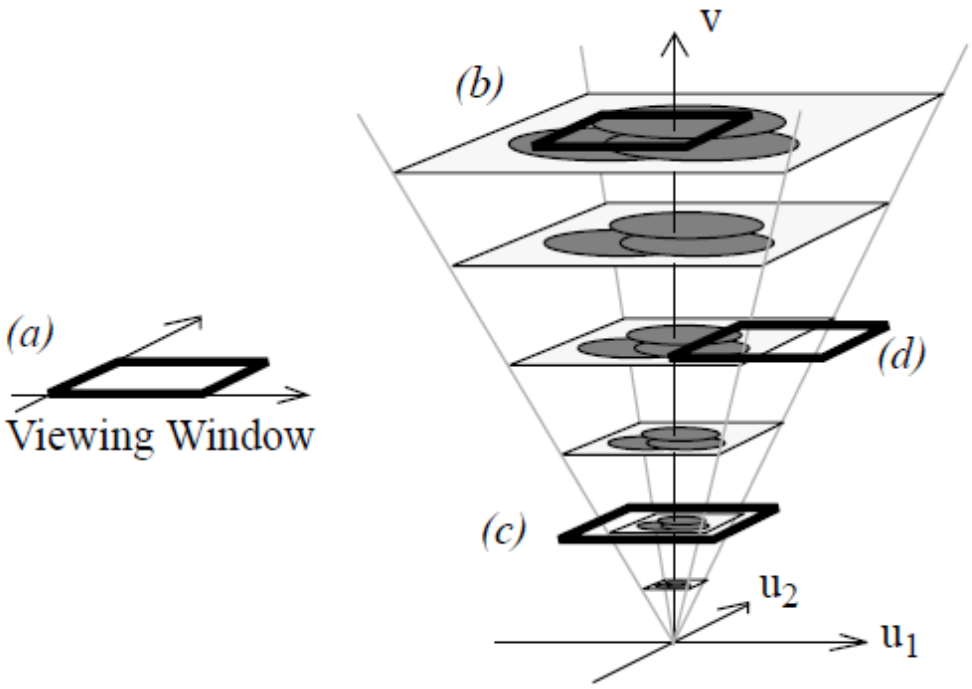
[Cockburn et al. 2002]

Zooming

- Issues:
  - Not easy to have intuitive zoom in/out control
    - e.g., using mouse scroll? Key press? Or a combination of both?
  - Jumps between pre-zoom and post-zoom views pose mental burden to users
    - Use animation for automatic zooming in between two zooming steps (e.g., Google Earth)

Space-Scale Diagrams

- An analytic framework for understanding zoom and pan interfaces.



[Furnas and Bederson, "Space-Scale Diagrams: Understanding Multiscale Interfaces," CHI'95.]

Space-Scale Diagrams

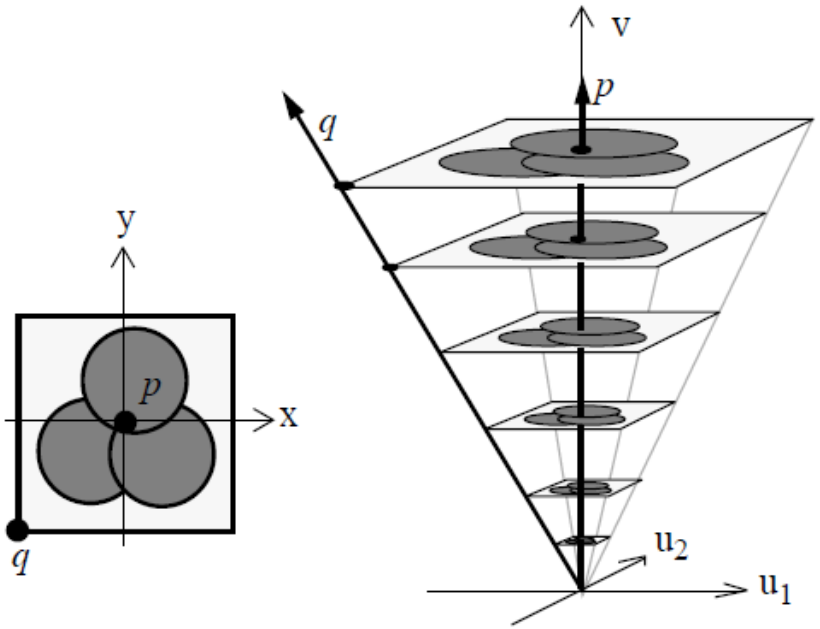
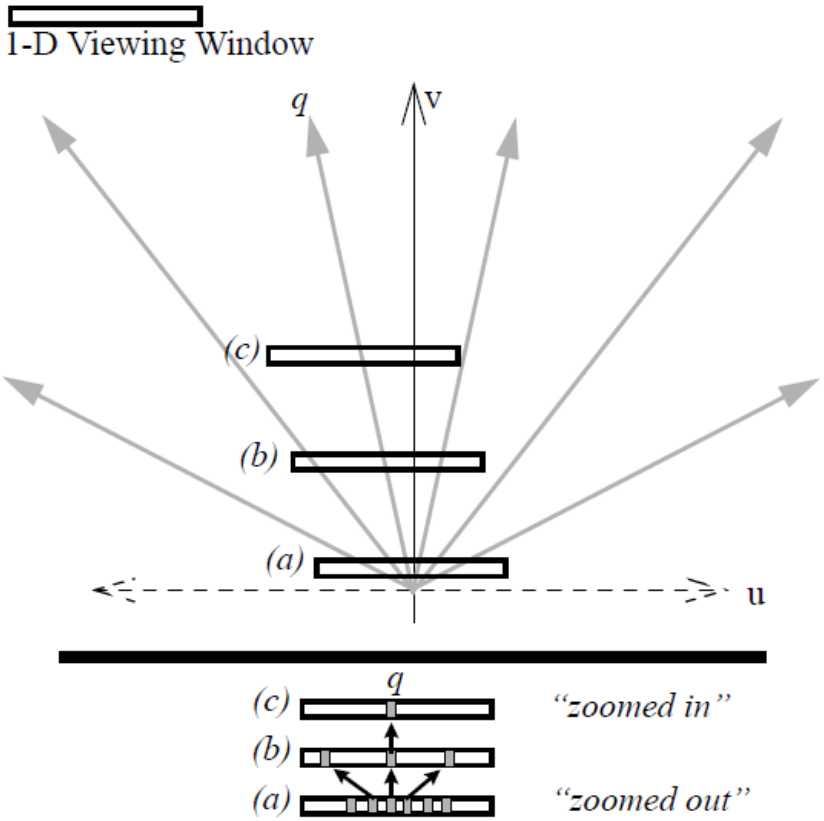


Figure 3. *Points like p and q in the original 2D surface become corresponding "great rays" p and q in the space-scale diagram. (The circles in the picture therefore become cones in the diagram, etc.)*

[Furnas and Bederson, CHI'95]

Space-Scale Diagrams



[Furnas and Bederson, CHI'95]

Space-Scale Diagrams

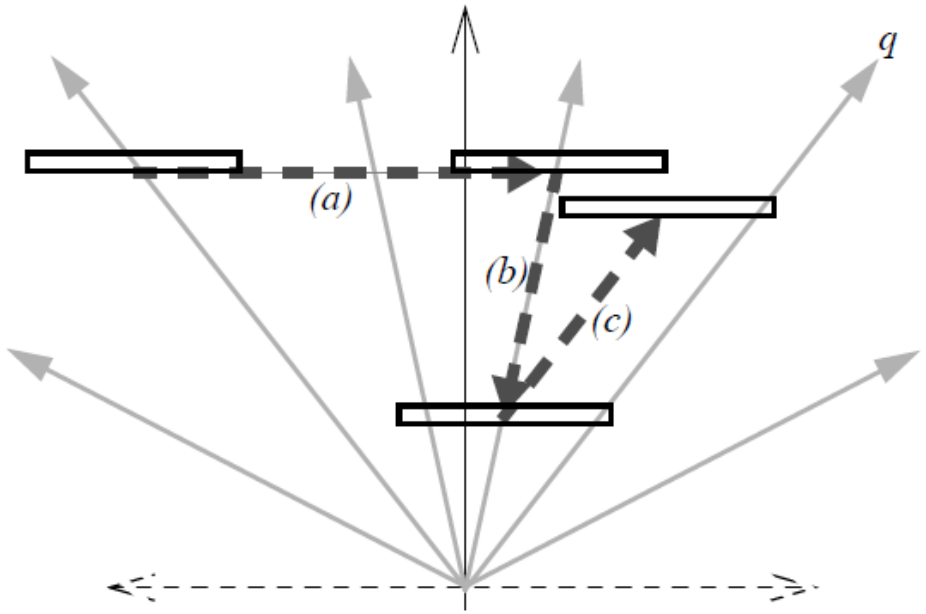


Figure 6. *Basic Pan-Zoom trajectories are shown in the heavy dashed lines:. (a) Is a pure Pan,. (b) is a pure Zoom (out), (c) is a "Zoom-around" the point q.*

[Furnas and Bederson, CHI'95]

Space-Scale Diagrams

- How to determine a proper pan and zoom at the same time?

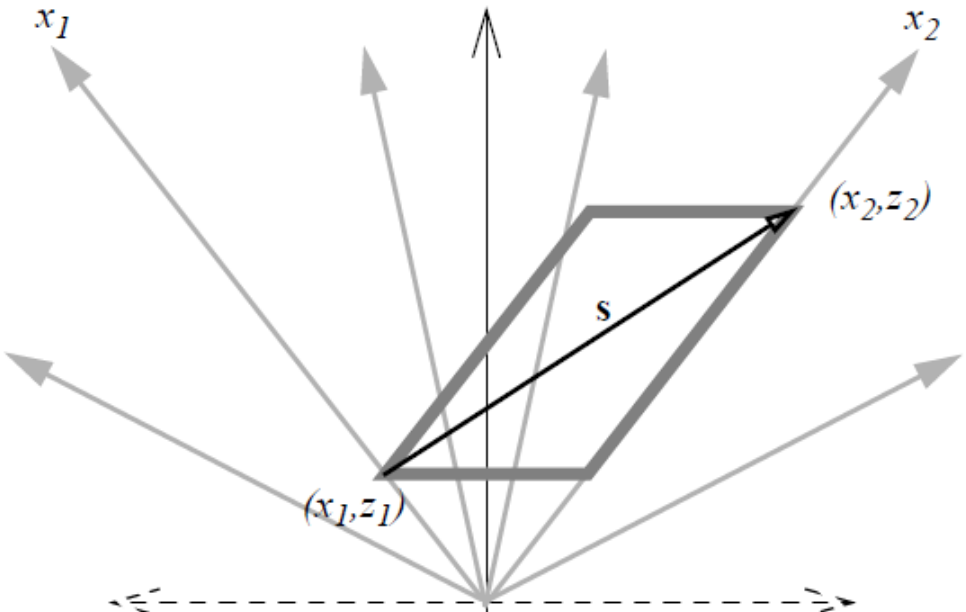
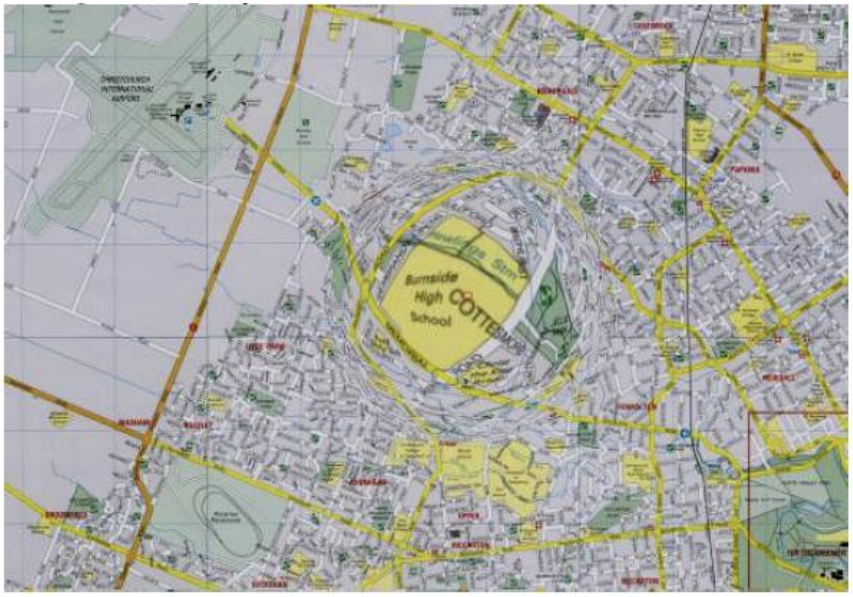


Figure 7. *Solution to the simple joint pan-zoom problem. The trajectory* **s** *monotonically approaches point 2 in both pan and zoom.*

[Furnas and Bederson, CHI'95]

Focus + Context

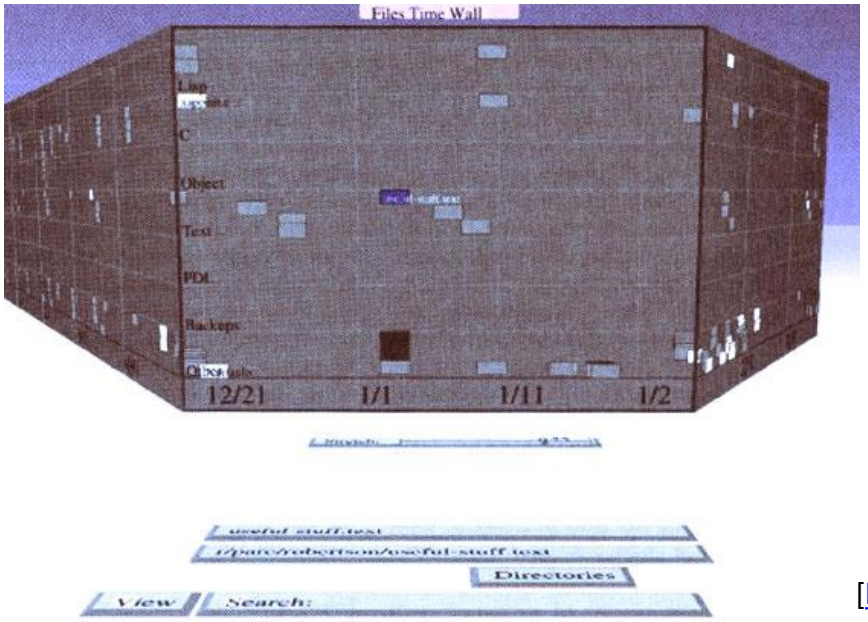
- Issues with O+D and Zooming: cognitive burden for users to correlate different views
- Focus + Context: focus within surrounding context in a single view
- Space can be stretched and squeezed, e.g., fisheye (distortion-based)
- Examples
  - The Perspective Wall
  - Table Lens



[Cockburn et al. 2002]

The Perspective Wall

- Make use of 3D perception
- Center panel for details and two side panels for context
- Problem: not screen space efficient

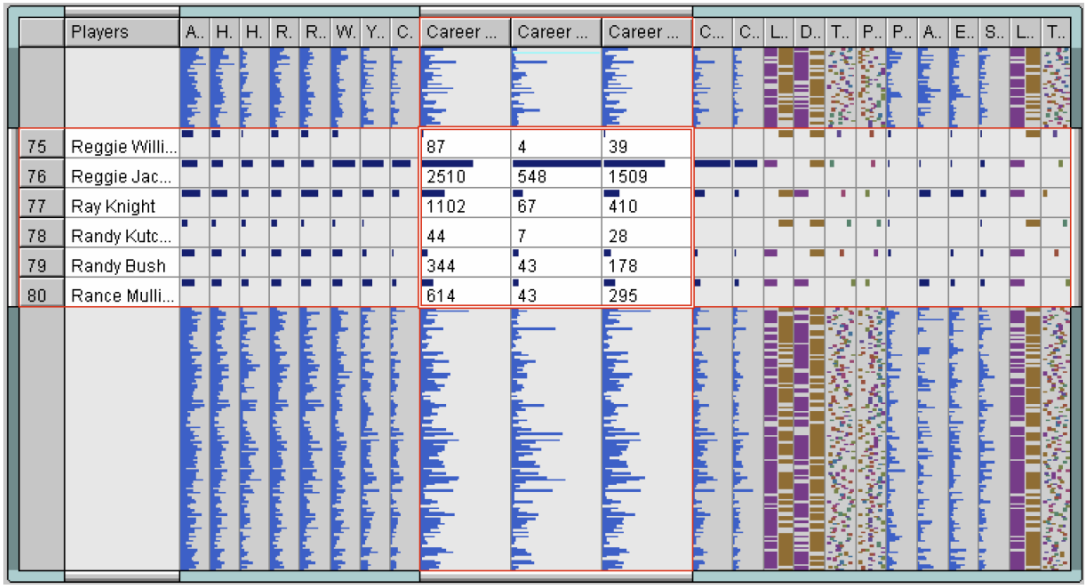


[http://www.youtube.com/watch?v=hYUZbrWtCZg]

[Robertson et al., “The Perspective Wall: Detail And Context Smoothly Integrated,” CHI’91.]

Table Lens

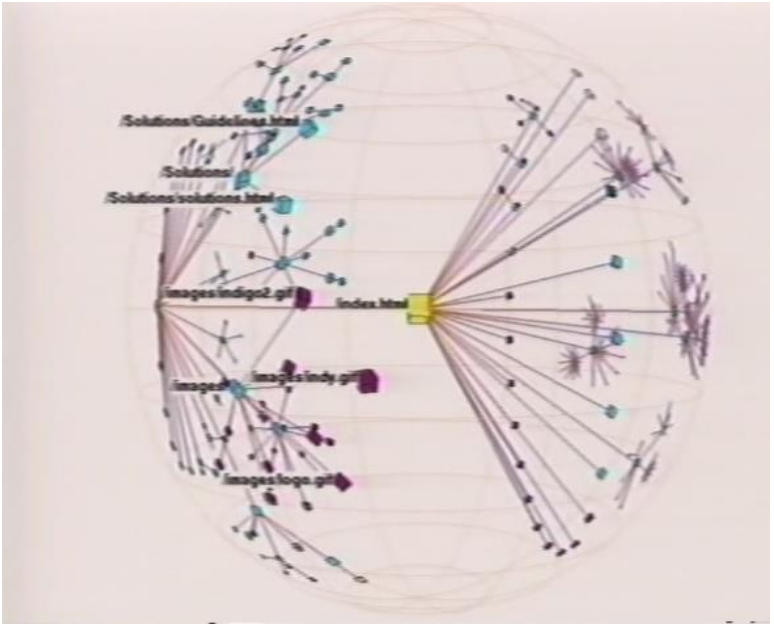
- Values of table entries are encoded as bars
- Fisheye: expand selected rows and columns
- Allow multiple focal points [http://www.youtube.com/watch?v=qWqTrRAC52U]



[Rao and Card, "The table lens: merging graphical and symbolic representations in an interactive focus + context visualization for tabular information," CHI'94.]

Hyperbolic Tree Browser

- Distortion based on hyperbolic geometry

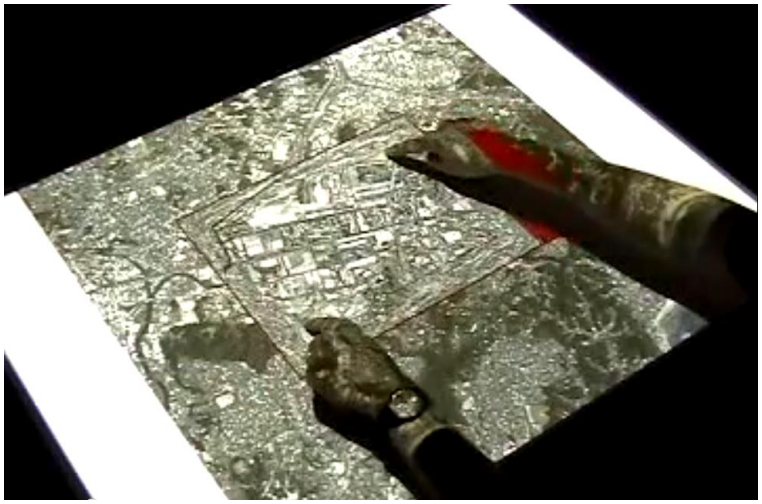


[T. Munzner, “Drawing Large Graphs with H3Viewer and Site Manager,” Graph Drawing’98.]

More Examples

Distorted map on a PDA
[http://www.youtube.com/watch?v=FDYo9uvrNJ0]

Rubber sheet map distortion
[http://www.youtube.com/watch?v=nTglJdK3kcY]



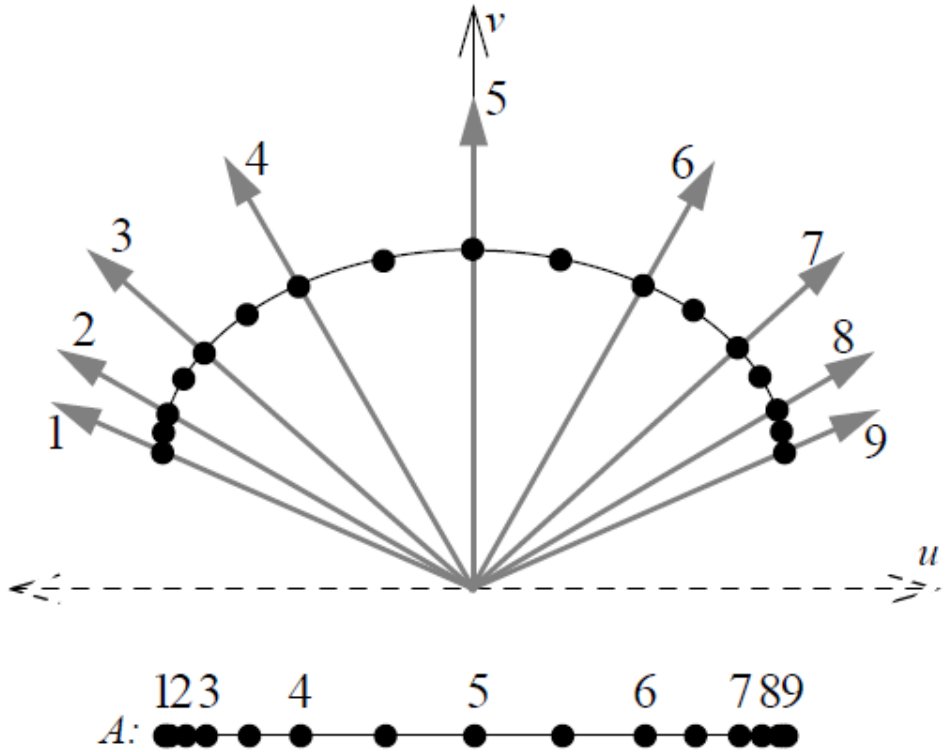
Pliable display on a table
[http://www.youtube.com/watch?v=m0LNHtRbaCA]

Generalized Focus+Context Model

- Degree of Interest
  DOI = API(x) – D(x, y)
  - x: a data point
  - y: current point of focus
  - API(x): A Priori Importance of x
  - D(x,y): Distance between x and y
- Increases with a priori importance and decreases with distance

[G.W. Furnas, "Generalized Fisheye Views," CHI'86.]

Fisheye View in Space-Scale Diagrams

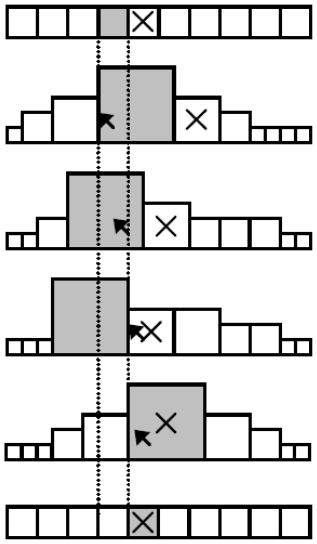


[Furnas and Bederson, CHI'95]

Problems of Distortion

- Not suitable if spatial judgement is needed
- Difficult for target acquisition
  - Items are displayed away from screen location

(a) The Mac Os X Dock icon-panel.



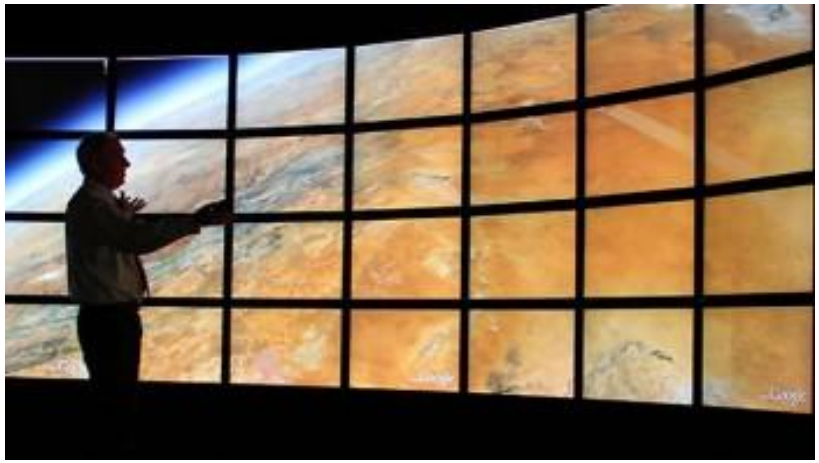
(b) Target movement caused by distortion. Items can be displayed at different locations (middle rows) from the actual locations needed to select them (top and bottom rows).

[Cockburn et al. 2002]

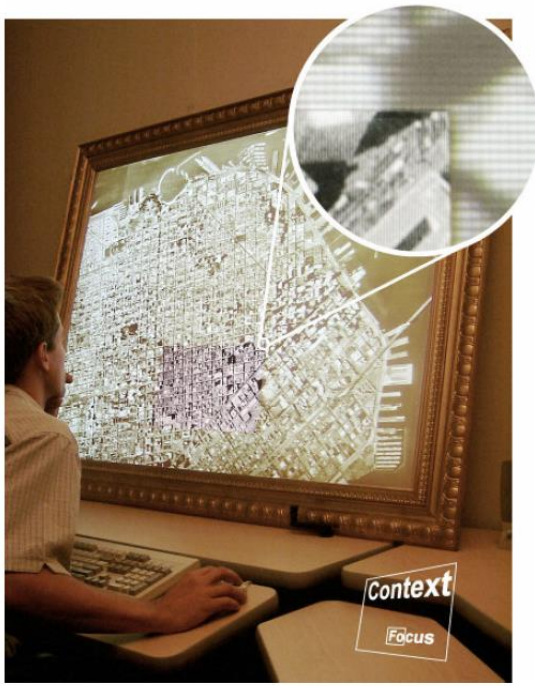
Focus+Context Without Distortion

- Wide field of view systems

Multiple large high resolution displays



Mixed resolution displays



[Cockburn et al. 2002, Baudisch 2002]

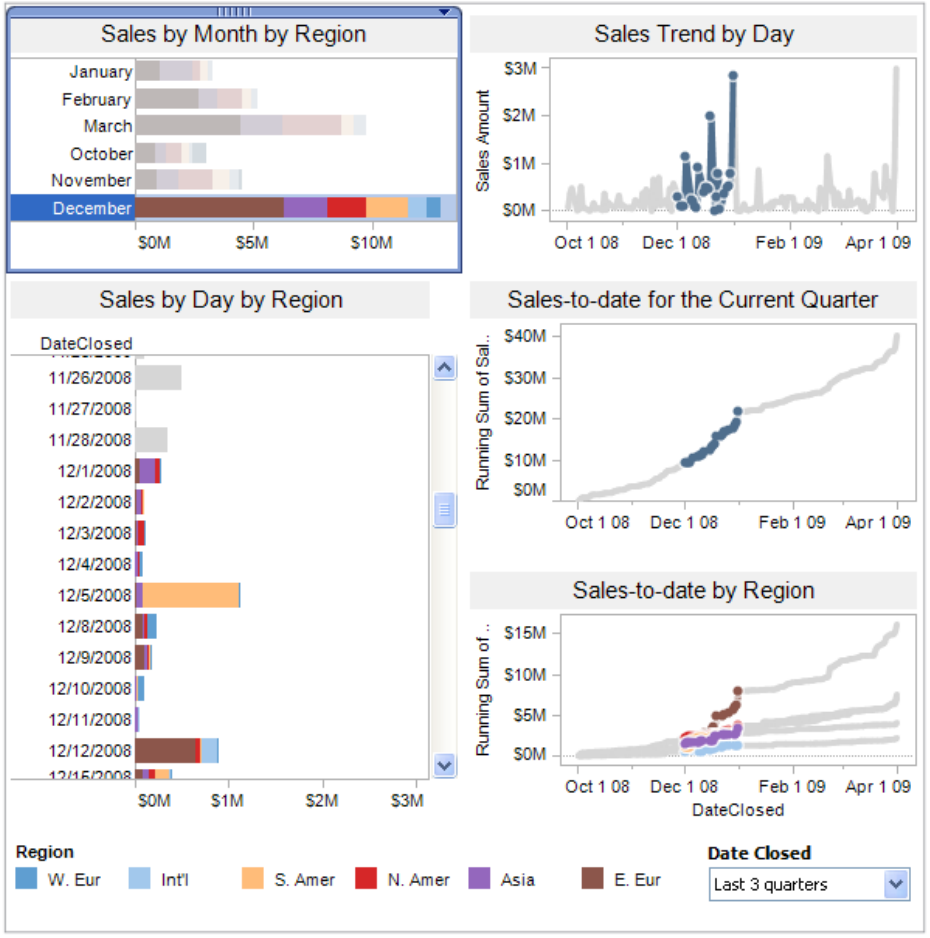
Linking & Brushing

- Link data in different visualization views
- Brushed points are highlighted in all visualizations of the same data set
- Possible to detect dependencies and correlations.
- Examples: multiple scatterplots, parallel coordinates (system: Tableau, GGobi)

https://www.youtube.com/watch?v=koFm2Rv0rnw

http://www.ggobi.org/demos/brushing-simple.html

Linking & Brushing



["Enhancing Visual Analysis by Linking Multiple Views of Data", Tableau whitepaper.]

References

- A. Cockburn, A. Karlson, and B. B. Bederson, “A review of overview+detail, zooming, and focus+context interfaces,” *ACM Computing Surveys*, 41(1), 2008.
- B. Shneiderman, “The Eye Have It: A Task by Data Type Taxonomy for Information Visualizations,” *Visual Languages*, 1996.
- D. Keim, “Information Visualization and Visual Data Mining,” *IEEE Transactions on Visualization and Computer Graphics*, 8(1), 2002, pp. 1 – 8.
- Colin Ware, *Information Visualization: Perception for Design*, 3rd ed., 2013. (Chapter 10)