Wayfinding and Navigation

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Perceptual Issues in Visual Interface Design

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Overview

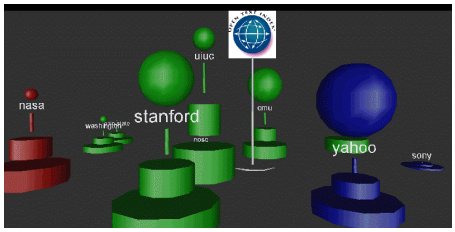
- **Motivation**
- **Viewpoint Control**
- **Map Orientation**
- **Focus, Context, and Scale**
- **Quantitative Measures of Effectiveness**

What is View Navigation?

- A way to interact with visualization
- One and two-dimensional examples
  - Navigating through web pages
    - Netscape = Internet Landscape?
  - Scrolling lists
    - Navigating linearly through a list of words

View Navigation

- Why navigate?
  - To make use of our spatial interpretation and navigation skills
- Consider a three-dimensional example
  - Data landscape



Bray, 1996

Data Landscape

- **Some Applications:**
  - **Visualizing Data from GIS Remote Sensing**
    - **Data landscape = natural choice**

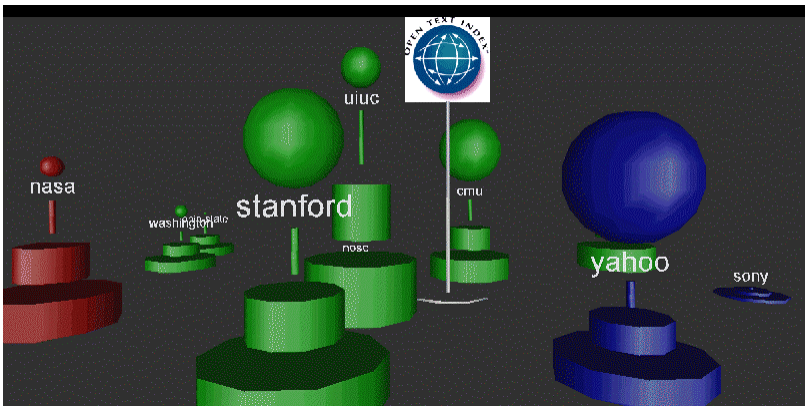
GIS Remote Sensing Data

http://www.tnt.uni-hannover.de/project/3dmod/land/visualization

Data Landscape

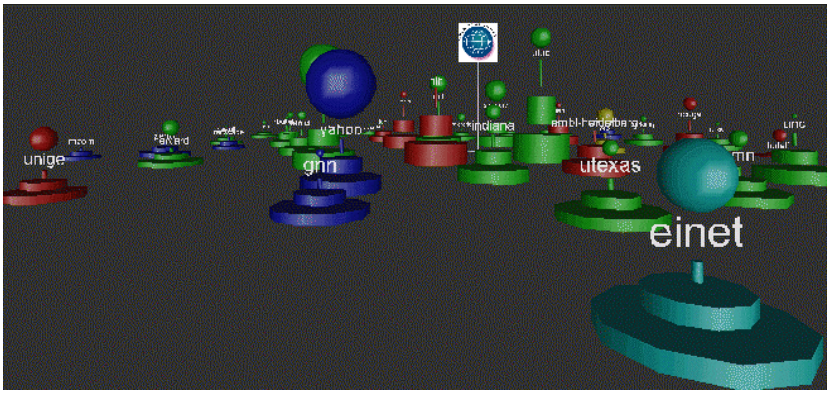
- **Some Applications:**
  - **Visualizing Data from GIS Remote Sensing**
    - **Data landscape = natural choice**
  - **Visualizing Data about the World Wide Web**
    - **Data landscape = not-so-natural choice**

"Measuring the Web"



Bray, 1996

“Measuring the Web”



Bray, 1996

Spatial Navigation Metaphors

- **What are they?**
  - **Various ways of controlling the viewpoints**
  - **Each has a different set of affordances**

Spatial Navigation Metaphors

- World-in-hand
- Eyeball-in-hand
- Walking
- Flying

World-in-hand

- User moves/rotates the virtual object
- Good for discrete, compact data objects
- Example
  - Demo from “The Labyrinth”

Spatial Navigation Metaphors

- World-in-hand
- Eyeball-in-hand
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Eyeball-in-hand

- Can control viewpoint like shooting with a camera
- Usually hard to control
- Least effective method

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Walking

- Walking in VR
- Problem
  - Might run into walls (real ones)

Walking

- Walking in VR
- Problem
  - Might run into walls (real ones)
- Solution
  - Devices that look like exercise treadmills
- Example
  - Virtual tourism

Spatial Navigation Metaphors

- World-in-hand
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Flying

- User can move freely in 3D
- Has aircraft-like interface
- Harder for people with actual flying experiences
- Example
  - GIS navigation system

Wayfinding and Map Reading

Seigel and White (1975) said…

There are three stages of wayfinding knowledge:

- Declarative knowledge
- Procedural knowledge
- Cognitive spatial map

Wayfinding and Map Reading

- Declarative knowledge
  - Information about key landmarks
  - No spatial understanding
- Procedural knowledge
- Cognitive spatial map

Wayfinding and Map Reading

= Church

= Farm

= Home

Wayfinding and Map Reading

- Declarative knowledge
- Procedural knowledge
  - Routes are developed
  - Landmarks act as decision points
  - No explicit and relative spatial positions
- Cognitive spatial map

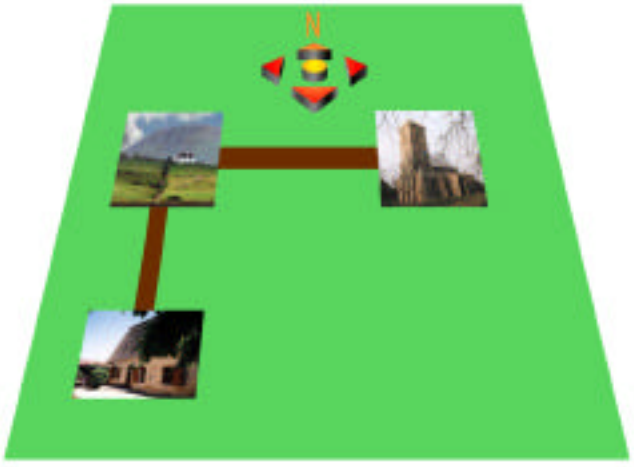
Wayfinding and Map Reading

- Route #1: Going from home to church
  - Go straight until you see the farm
  - Turn right and keep going till you see the church
- Route #2: Going from church to home
  - Go straight until you see the farm
  - Turn left and keep going till you see home

Wayfinding and Map Reading

- Declarative knowledge
- Procedural knowledge
- Cognitive spatial map
  - Bird's eye view of the environment is formed
  - Includes rough distances between locations

Wayfinding and Map Reading



Wayfinding and Map Reading

Kosslyn (1987) said…

- **Only two kinds of wayfinding knowledge**
  - **Categorical**
  - **Coordinate**
- **Not acquired in any particular order**
- **Supported by a recent study by Colle & Reid**

Using Landmarks in VR

- **Make sure enough of them are visible**
- **They should look as different as possible**
- **They should be seen at all scales**
- **They should be placed on decision points**

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Which Way's Up?

- North-up map
- Track-up map
- North-up map with user view
  - Almost as good as track-up map
  - Good for sharing route information with others
  - Best of both worlds

Making Better Maps

- Use overview maps
- Show user location and direction
- Show images of key landmarks
- Consider procedural instructions

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The *Focus-context* Problem

- **The problem occurs when…**
  - **One tries to find detail in a context that is too large**
- **Where can it occur?**
  - **Spatial Scale**
  - **Structural Scale**
  - **Temporal Scale**

Solving the Problem

- **Techniques**
  - **Distortion**
  - **Rapid zooming**
  - **Elision**
  - **Multiple windows**

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Measuring Effectiveness

- Is there a way to quantitatively evaluate a view navigation system?
- Furnas proposed that we can study the system's
  - Efficient View Traversability (EVT)
  - View Navigability (VN)

Efficient View Traversability (EVT)

- **EVT depends on:**
  - **The maximum number of out-going links or *out-degree of the viewing graph*(MOD)**
  - ***Diameter* of the viewing graph (DIA)**
- **So for any viewing graph G:**
  - **EVT(G) = (MOD(G),DIA(G))**

Efficient View Traversability (EVT)

- **Examples:**
  - **EVT(Scrolling-list) = (O(1),O(n))**
  - **EVT(Multi-scrolling-list) = (O(1),O(sqrt(n)))**
  - **EVT(Fisheye-sampled-list) = (O(log n),O(log n))**

View Navigability (VN)

- **The ideal navigation system would fully satisfy the following VN properties:**
  - **VN1: Outlink-info must be everywhere well matched**
  - **VN2: Outlink-info must be "small"**
- **Outlink-info of a node N is the set of all nodes that N can reach**

Why the Web is Bad

- **The WWW is in fact very bad in terms of view navigation**
- **As a case study…**
  - **Let's look at how well the World Wide Web meets the rules of VN**

Why the Web is Bad

- **VN1: Outlink-info must be everywhere well matched**
  - **To satisfy this, each link of the WWW has to describe all possible web pages that it can reach directly or indirectly**
  - **Have to use an exhaustive list to satisfy VN1**

Why the Web is Bad

- **VN2: Outlink-info must be "small"**
  - **To satisfy this, the description of the possible web pages that a link can reach directly or indirectly should be kept to a minimum**
  - **Cannot use an exhaustive list (too long)**
  - **To fix it, can consider using semantic notions**
    - **Attributes**
    - **Abstractions**

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