A Quick Overview of Information Visualization

New Co I – May 2001

(Adapted by Tony Krebs from…)

The Eyes Have It: User Interfaces for Information Visualization

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Member, Institutes for Advanced Computer Studies & Systems Research

[Abridged]

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Human-Computer Interaction Laboratory

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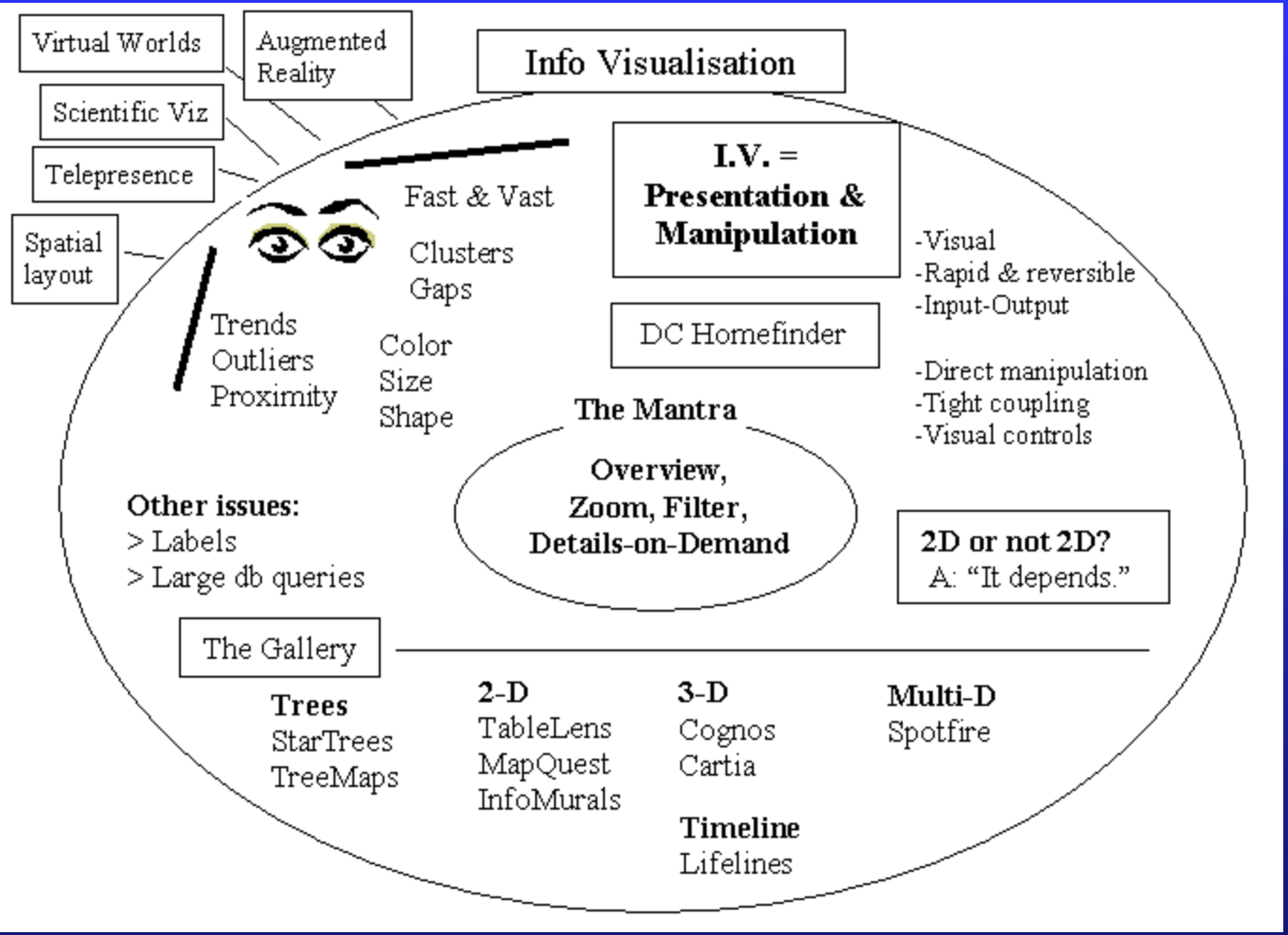
Overview of the Presentation



User Interface Design Goals

- **Cognitively comprehensible:**
  Consistent, predictable & controllable

- **Affectively acceptable:**
  Mastery, satisfaction & responsibility

NOT:

~~Adaptive~~, ~~autonomous~~ & ~~anthropomorphic~~

Scientific Approach ~~(beyond user friendly)~~

- Specify users and tasks
- Predict and measure
  - time to learn
  - speed of performance
  - rate of human errors
  - human retention over time
- Assess subjective satisfaction

  (Questionnaire for User Interface Satisfaction)
- Accommodate individual differences
- Consider social, organizational & cultural context

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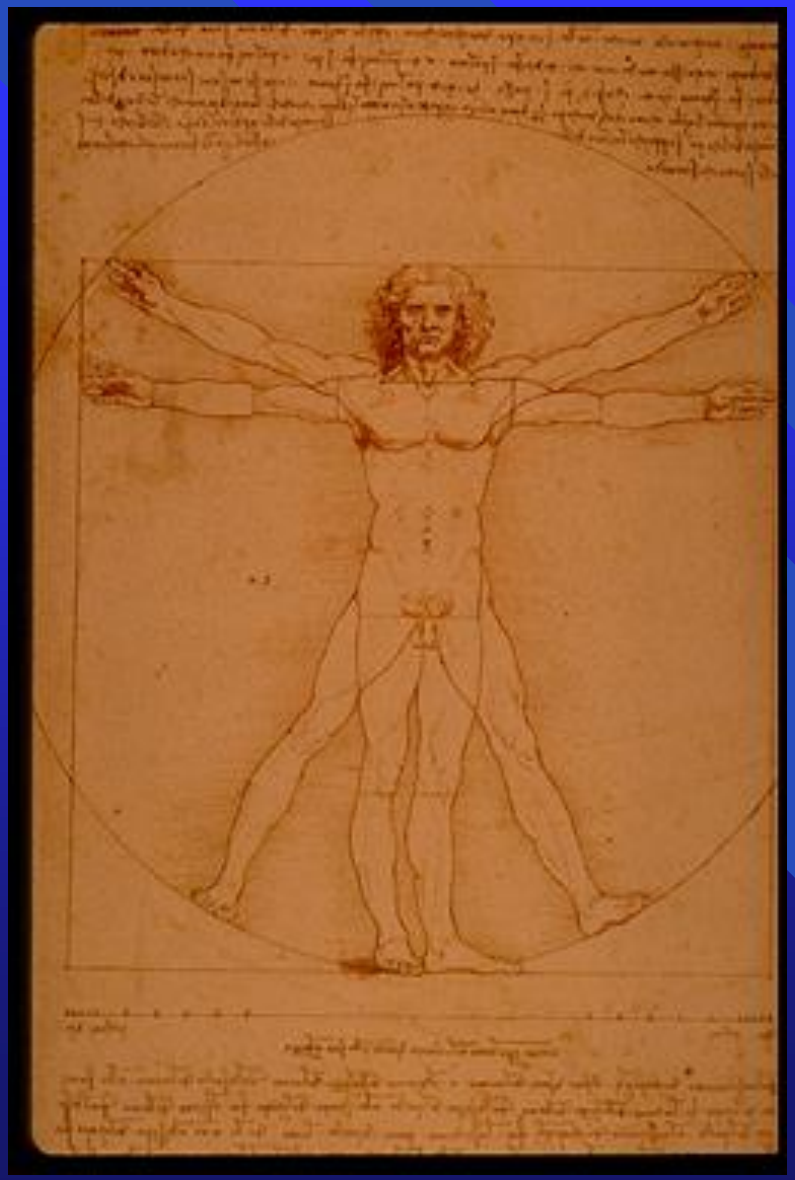
Information Visualization



The eye…
the window of the soul,
is the principal means
by which the central sense
can most completely and
abundantly appreciate
the infinite works of nature.

Leonardo da Vinci
(1452 - 1519)

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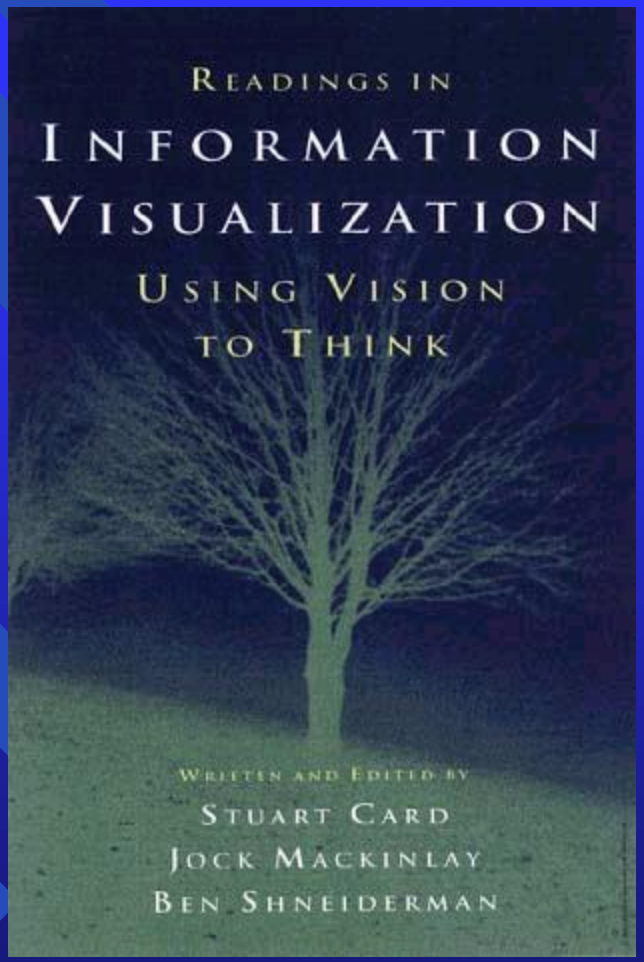
Information Visualization: Using Vision to Think

- **Visual bandwidth is enormous**
  - Human perceptual skills are remarkable
    - Trend, cluster, gap, outlier...
    - Color, size, shape, proximity...
  - Human image storage is fast and vast
- **Opportunities**
  - Spatial layouts & coordination
  - Information visualization
  - Scientific visualization & simulation
  - Telepresence & augmented reality
  - Virtual environments



Information Visualization: Definition

Compact graphical presentation and

user interface for

manipulating large numbers of items (10^2 - 10^6),

possibly extracted from far larger datasets.

Enables users to make

discoveries,

decisions, or

explanations

about

patterns (trend, cluster, gap, outlier...),

groups of items, or

individual items.

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Information Visualization: Design Guidelines

Direct manipulation strategies

- Visual presentation of query components
- Visual presentation of results

- Rapid, incremental and reversible actions
- Selection by pointing (not typing)
- Immediate and continuous feedback

- Reduces errors
- Encourages exploration

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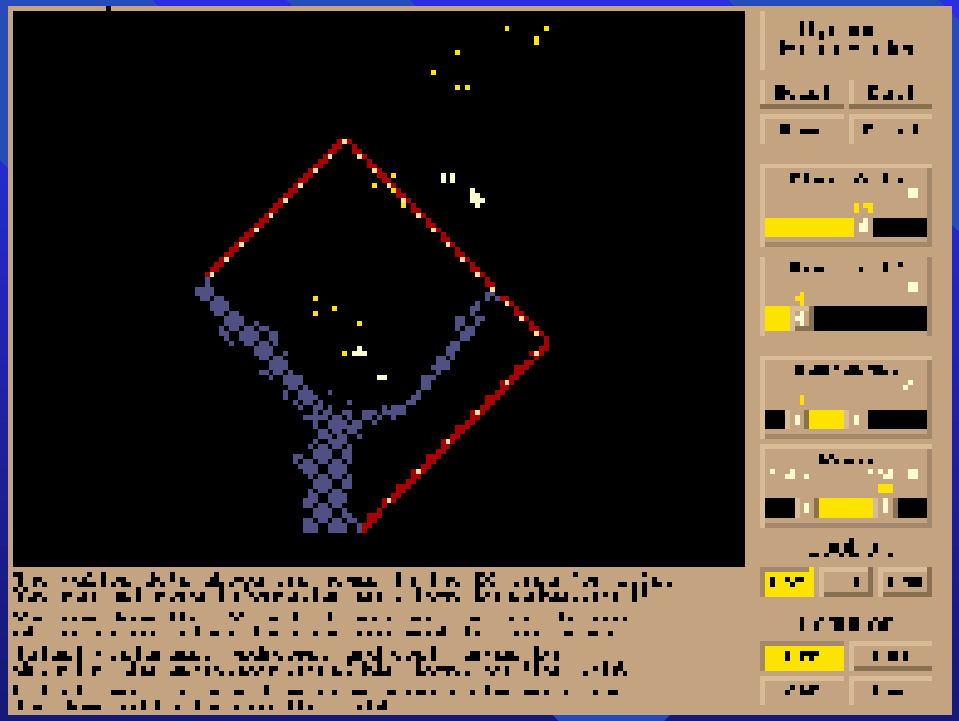
Example: HomeFinder for Washington DC

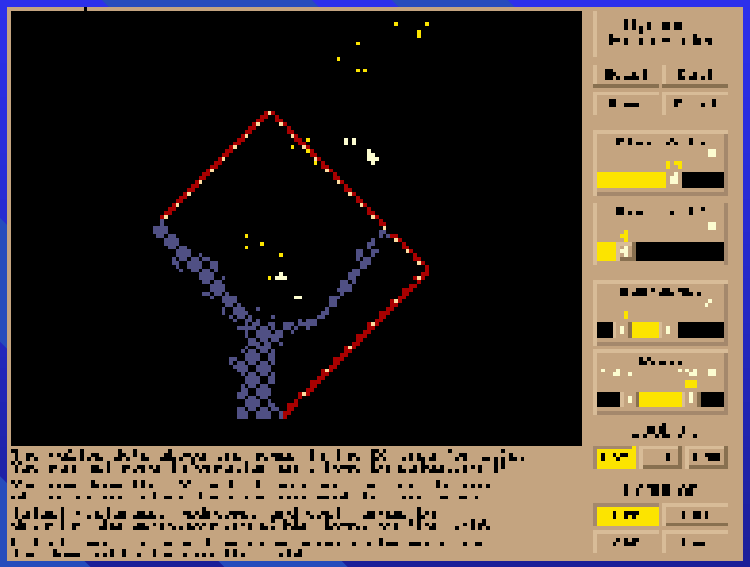
HomeFinder application

Built from SpotFire technology



Example: HomeFinder for Washington DC

- Front end to Realtor MLS
- Direct manipulation w/ instant feedback.
- Reversible actions.
- No keyboard required.
- No search button.
- No error messages.
- Double-box slider controls.
- It works because housing is “location, location, location”.



Visual Info. Seeking: Design Principles

- **Dynamic Queries**
  - Visual query creation and immediate output
  - Rapid, incremental, and reversible actions
  - Visual controls: sliders, buttons, selectors
- **Overview Display with Zoom-Focus**
  - Starfield or scatterplot
  - Area map
  - Use of color for coding traits, patterns, intensity, frequency
  - Some form of navigation and scaling
  - Out-of-the-way labeling and/or details
- **Tight Coupling**
  - Output becomes input…with details-on-demand

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Information Visualization: The Mantra

- **Overview** Gain an overview of the entire collection

Information Visualization: The Mantra

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- **Zoom** Zoom in on items of interest

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Overview, Zoom, Filter, Details-on-demand

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Information Visualization: Additional Tasks

- **Overview** Gain an overview of the entire collection
- **Zoom** Zoom in on items of interest
- **Filter** Filter out uninteresting items
- **Details-on-demand** Select an item or group and get details when needed
- **Relate** View relationships among items
- **History** Keep a history of actions to support undo, replay, and progressive refinement
- **Extract** Allow extraction of sub-collections and of the query parameters

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Information Visualization: Data Types

- **1D/Linear** Document Lens, SeeSoft, Info Mural, Value Bars
- **2D/Map** GIS, ArcView, PageMaker, Medical imagery
- **3D/World** CAD, Medical, Molecules, Architecture
- **Time data** Perspective Wall, LifeLines, Lifestreams, Project Managers, DataSpiral
- **Tree/Hierarchy** Conetree/Hyperbolic, Treemap
- **Multi-D** Parallel Coordinates, Spotfire, XGobi, Visage, Influence Explorer, TableLens, DEVise
- **Networked** Netmap, netViz, SeeNet, Butterfly, Multi-trees

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Information Visualization: Display Types

- **Linear Overview** — Word multi-page view, SeeSoft
- **2D Tables** — TableLens
- **2D Map** — MapQuest, Homefinder-DC
- **3D Displays** — ChartJunk, Starfields, data mountains
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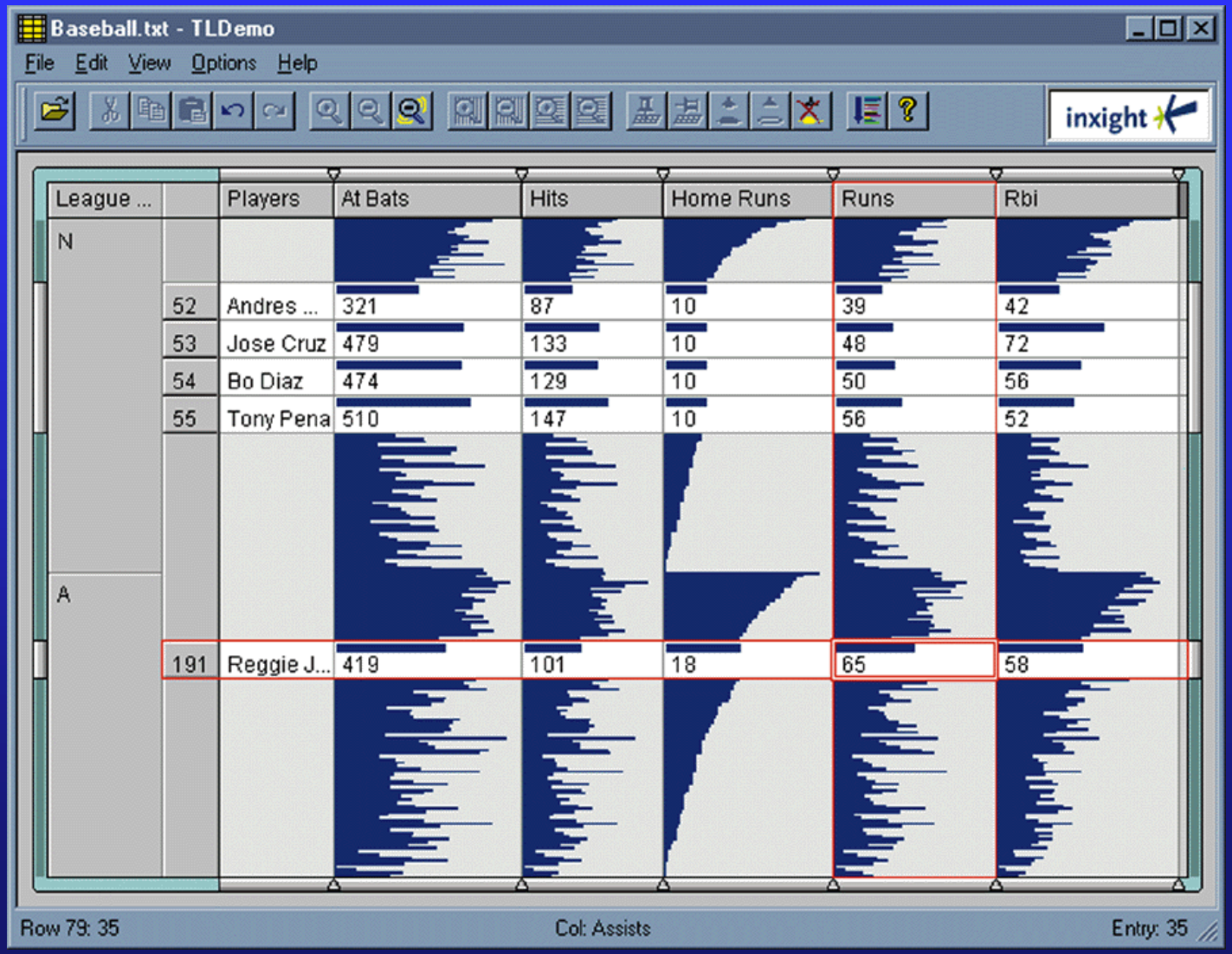
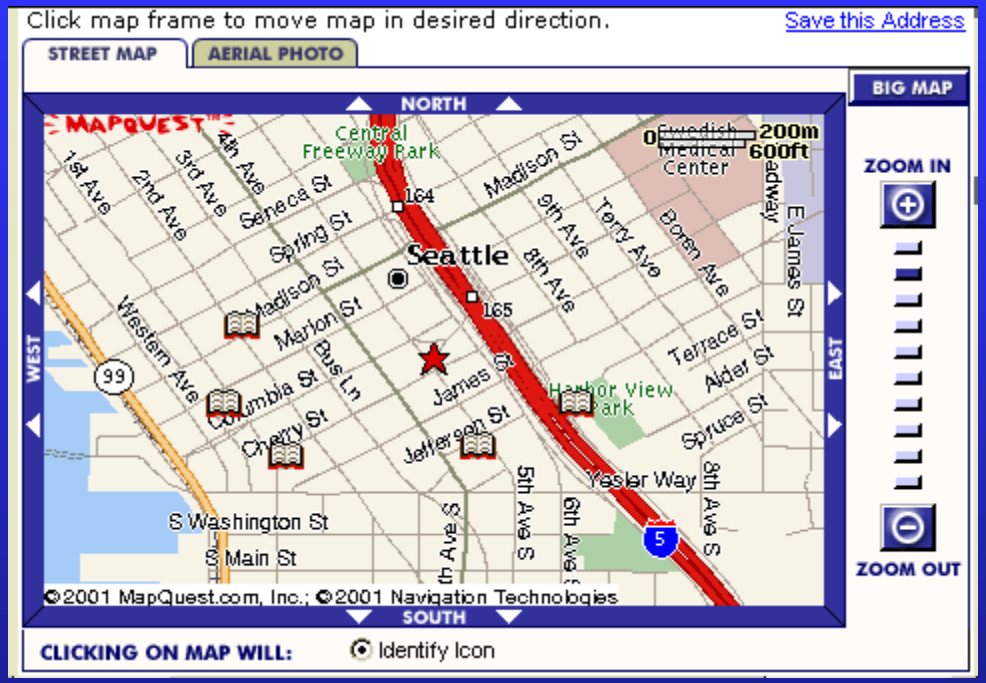
Table Lens: Zoom-Focus on large tables



Real World Maps - Mapquest

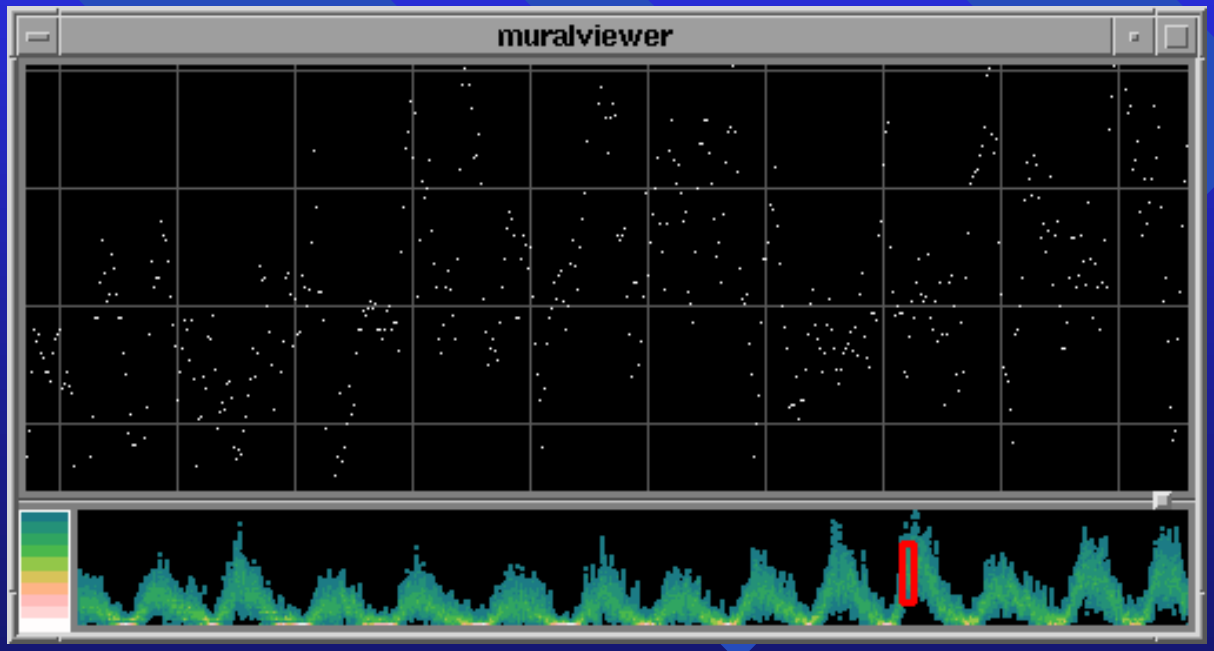


- Interactive through direct manipulation
- Overview and detail focus
- Details-on-demand
- Shows location of nearest 5 bookstores

- (Our building is on the wrong side of the street.)

Information Mural

An Information Mural is a 2D, graphical representation of a large information space fit entirely within a display window. The miniature representation is drawn using anti-aliasing techniques and intensity shading or varying pixel size, and is useful for visualizing overall trends and distribution patterns.



Mural of the number of sun spots recorded daily, 1850-1993

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3D Viz: The Good, the Bad & the Ugly

- **Immersive Virtual Environment**
  Heads-up display, stereo sound, and head tracking
- **Desktop 3D Worlds**
  Medical imagery, architectural walk-throughs, scientific vizualization
- **Desktop 3D Artificial Worlds**
  Virtual shopping mall, chat rooms w/ avatars, file cabinets
- **Desktop 3D for Info Visualization**
  Perspective wall, treemaps, cone trees, starfields, data mountains
- **3D "Chartjunk"**
  Extruded barcharts, pie charts, histograms

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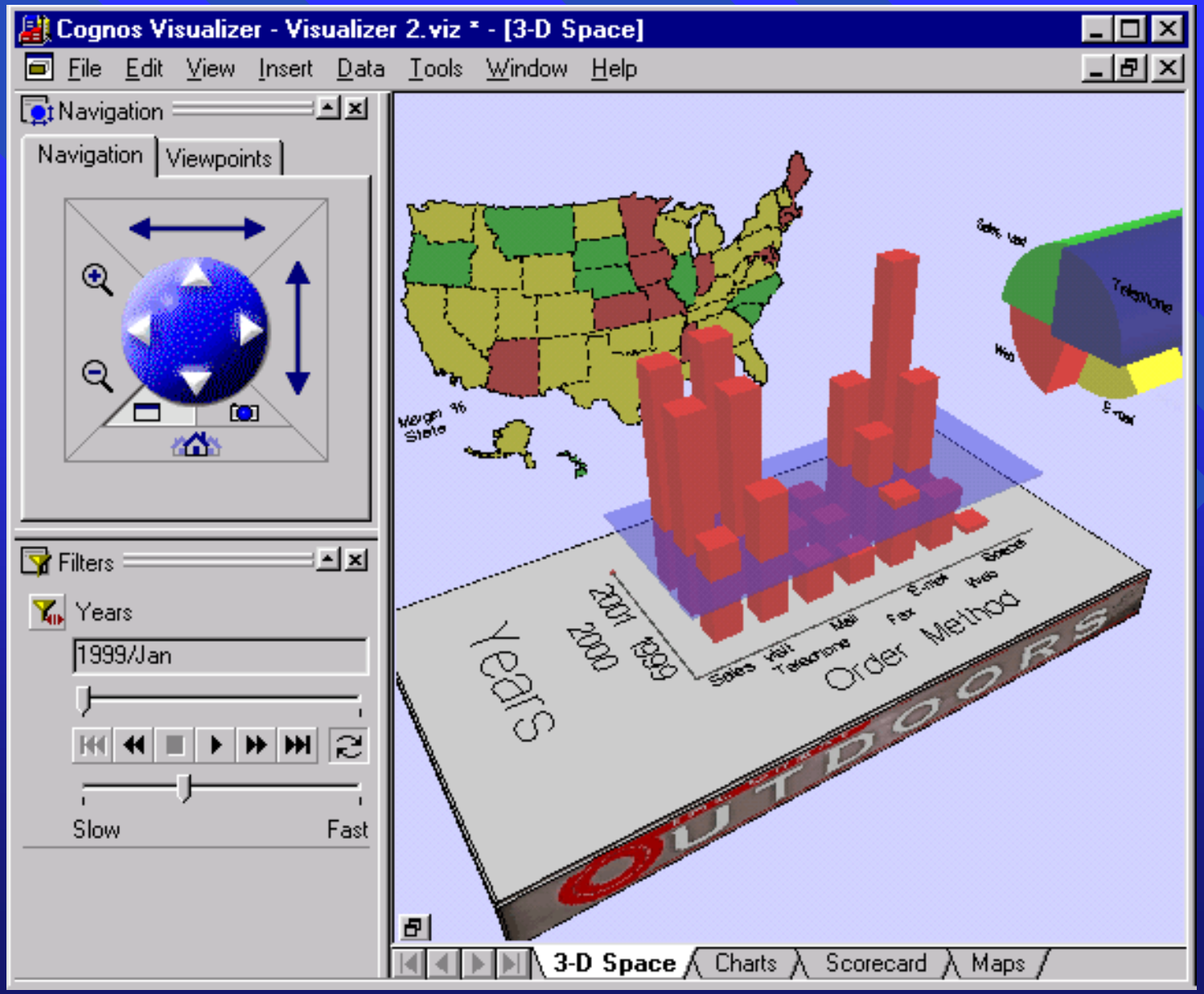
(Chart junk ?)


Cognos Visualizer - Visualizer 2.viz * - [3-D Space]
File Edit View Insert Data Tools Window Help
Navigation
Navigation Viewpoints
Filters
Years
1999/Jan
Slow
Fast
Years
2001
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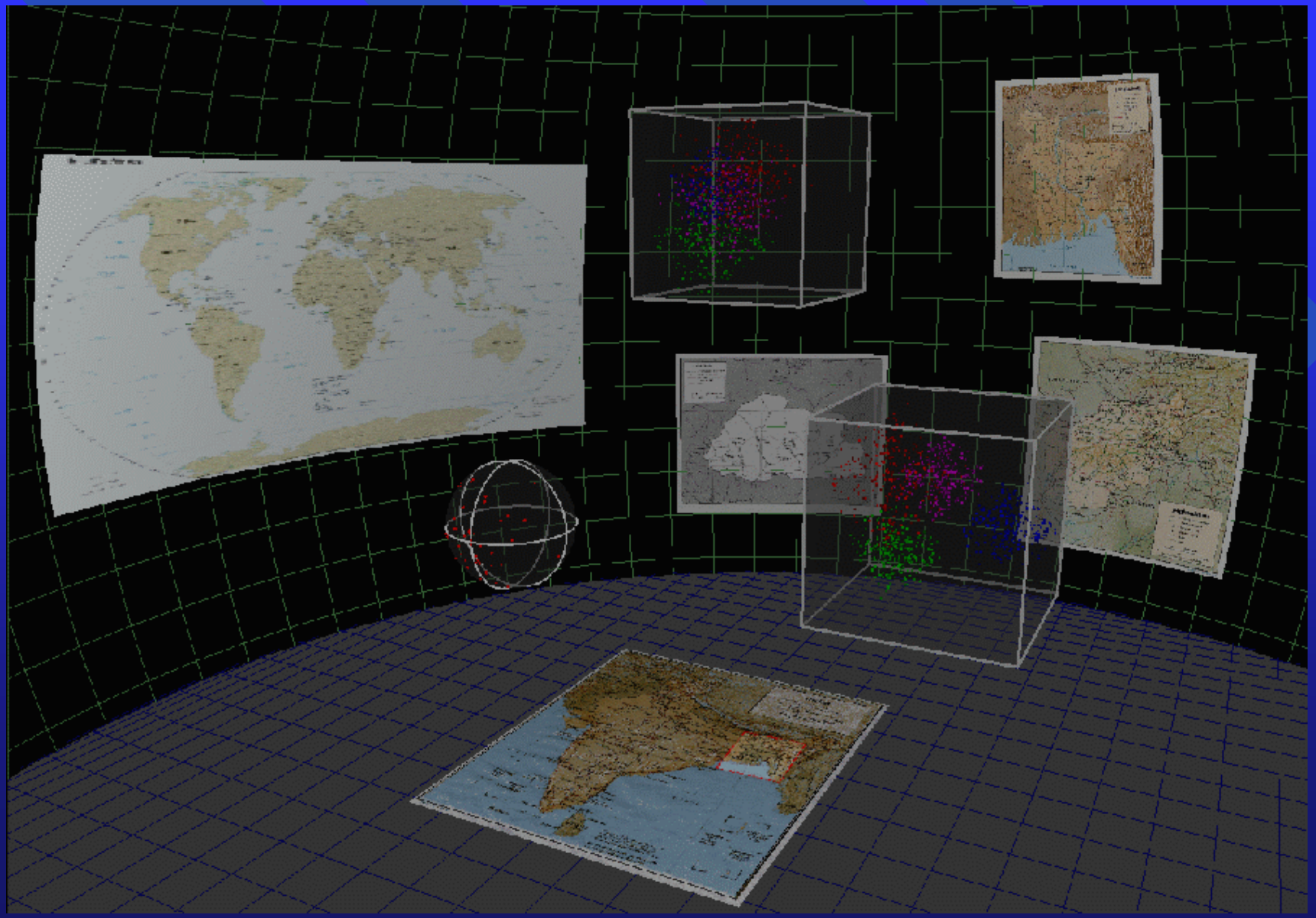
Order Method
Sales Visit
Telephone
Mail
Fax
E-mail
Web
OUTDOORS
3-D Space
Charts
Scorecard
Maps

Starlight



CARTIA

(out-of-business)

ThemeScape Map Viewer: Technology News Aug 5 1999 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://demo.cartia.com/technews/map1024.html Go

Map: Technology News Aug 5 1999
Size: 535 documents

Map Legend | Search | Topic List | Flags

IP Vision Optical

Labels and Peaks
Peaks represent large numbers of similar documents. Labels help you see what kind of information is contained in these areas.

Document Points
Dots represent documents on the map. Pause your mouse cursor over the map to view the topics in an area, or click to browse document titles.

Search Results
Search results are drawn as blue dots on the map. Numbered dots represent the top documents displayed in the results list.

Flags
Mark interesting documents with flags to help you find them later. You can also create summary pages listing all the documents you marked.

For more information: Quick Tour | Online Help

Taiwan Texas Assets
IBM Analog Patents
Microworkz Earthlink PC
DSL Frame Relay
Intel Chip Stock
Baratz Java Sun
Music Rio Diamond
Storage Telecom Apple Chips
Security Message Microsoft
Search Engines Rages
Yankee DSL Gaming
Pet Framed Photos
Global Motorola Satellite
Barbie Hot Wheels Children
Dreamcast Sega Console
TV Cable Games
Federal Electric Clinton
Stock Pharmacy Amazon
Radio Search Engine
Banks Thrifts Credit Union
Walks Chases Balls
Sports Stock Asset
Film Title Library

Done Internet

3D Info Visualizations: Pros & Cons

- **Looks real cool!**
- **May be easier to navigate**
- **Great for geographic or 3D source data**

- **Tends to waste display space**
- **Perspective shortening**
  Obscuring items behind, comparing "heights" at different "distances"
- **Multiple 2D, coupled displays often easier to scan and comprehend**

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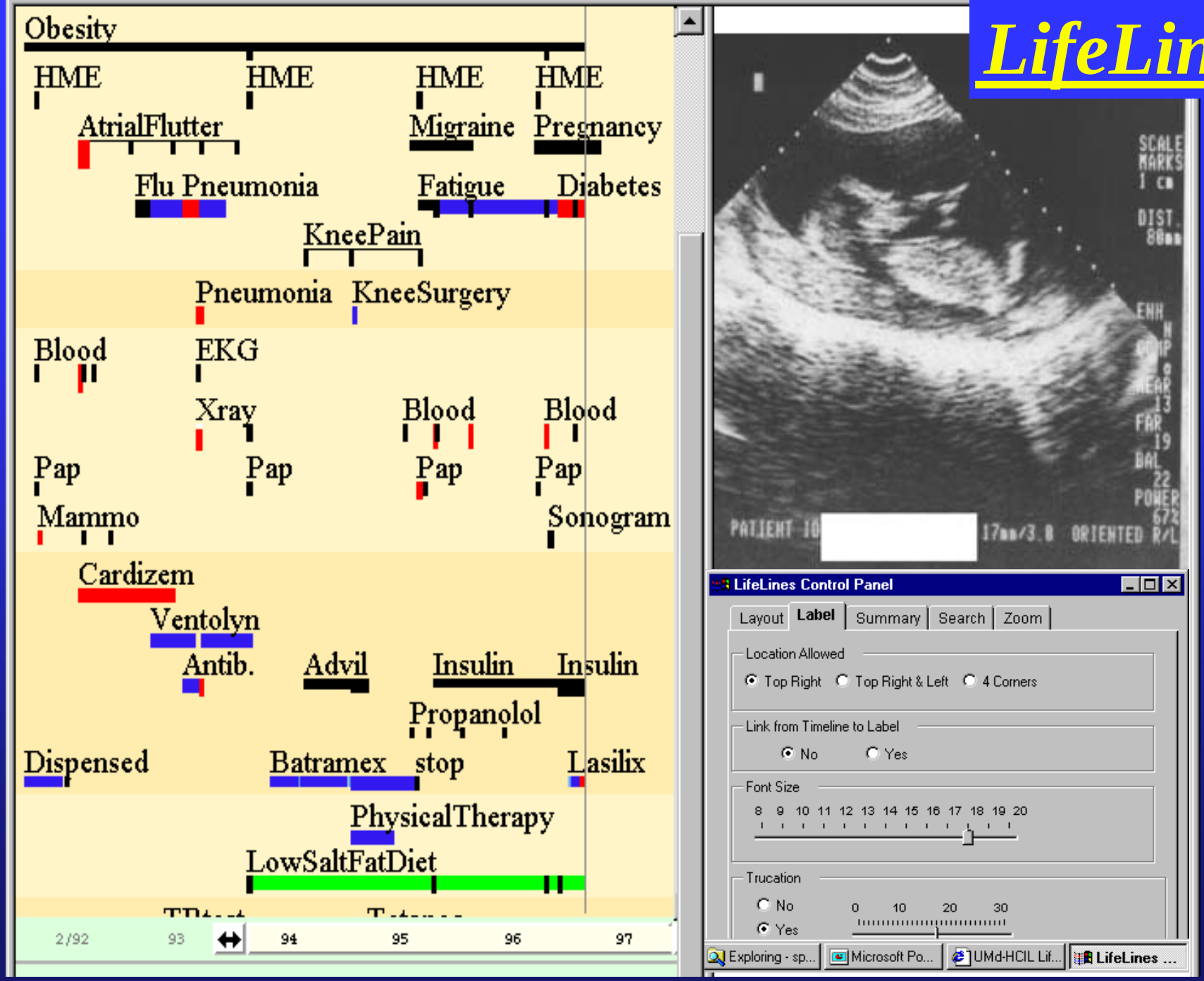
Current HCIL Research - LifeLines

Temporal data visualization

- Medical patient histories
- Customer relationship management
- Legal case histories

LifeLines


Obesity
HME
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AtrialFlutter
Migraine
Pregnancy
Flu Pneumonia
Fatigue
Diabetes
KneePain
Pneumonia
KneeSurgery
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Pap
Pap
Pap
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Mammo
Sonogram
Cardizem
Ventolyn
Antib.
Advil
Insulin
Insulin
Propanolol
Dispensed
Batramex
stop
Lasilix
PhysicalTherapy
LowSaltFatDiet
2/92
93
94
95
96
97
SCALE MARKS 1 cm
DIST. 88mm
PATIENT ID
17mm/3.0
ORIENTED R/L
LifeLines Control Panel
Layout
Label
Summary
Search
Zoom
Location Allowed
Top Right
Top Right & Left
4 Corners
Link from Timeline to Label
No
Yes
Font Size
8 9 10 11 12 13 14 15 16 17 18 19 20
Trucation
No
Yes
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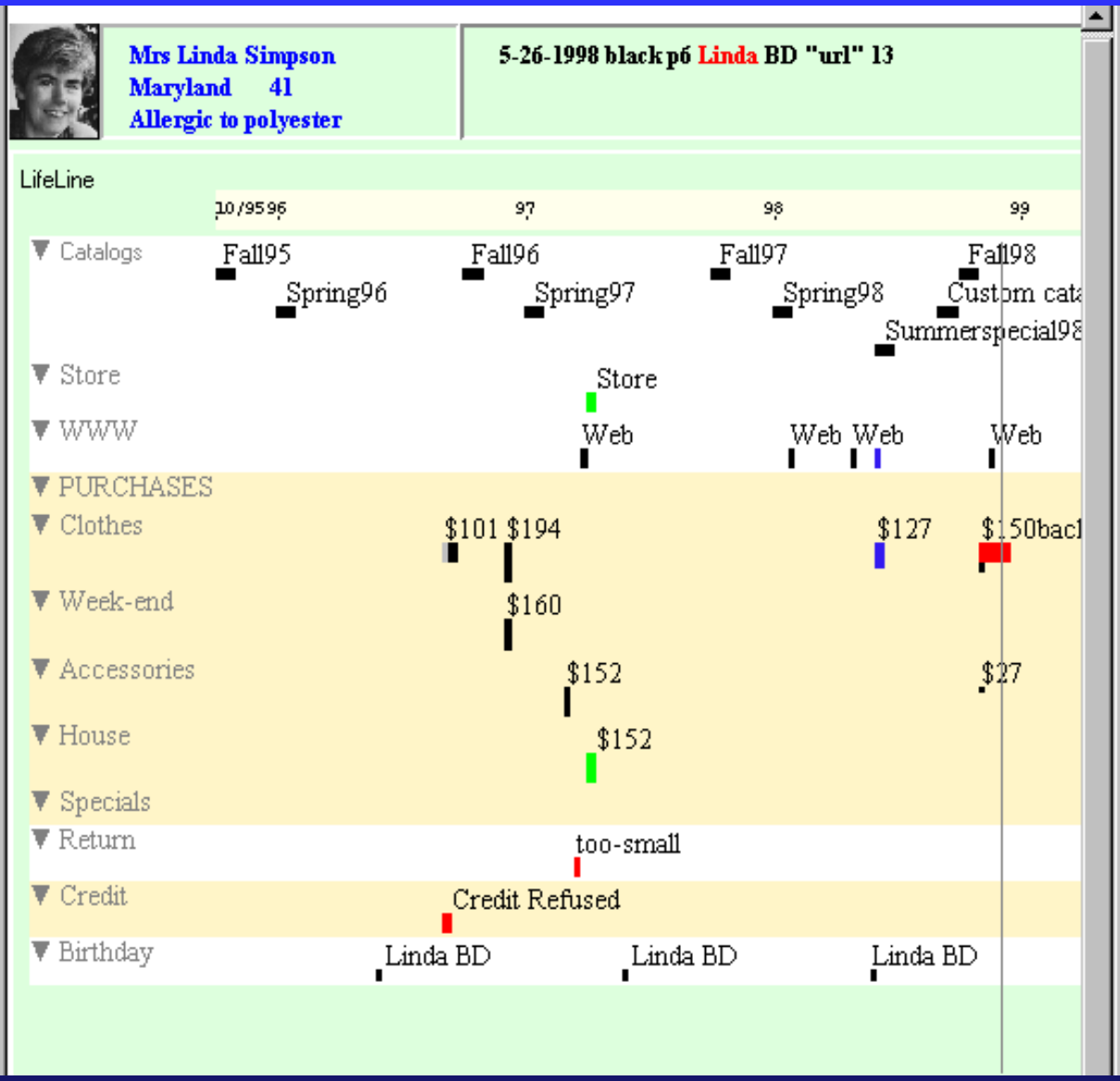
Exploring - sp...
Microsoft Po...
UMd-HCIL Lif...
LifeLines ...

Customer History - LifeLines



Linda Simpson ORDER#614345 (MOST RECENT)
11-1-1997,$150, Visa card, order by phone

D45F224: Boots - 4 - Black
----> **BACKORDER - estimated shipping 12-15**
D45F236: Gloves - Black - M
A78156: Corduroy pants - Tan - L
157826: Hat - Grey - M

Kids Backcountry hiking boots
Leather boots with super grip soles.

Information Visualization: Display Types

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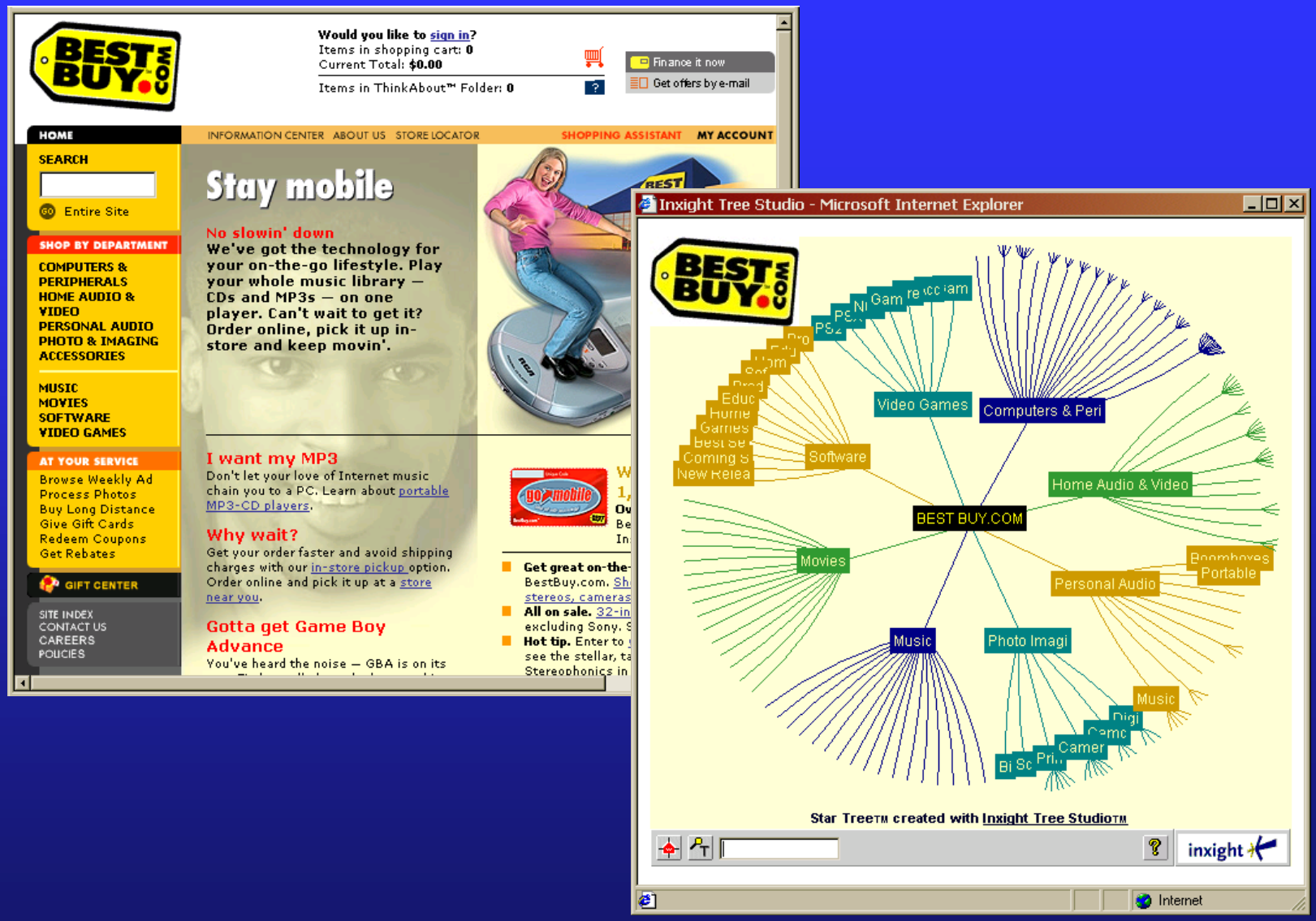
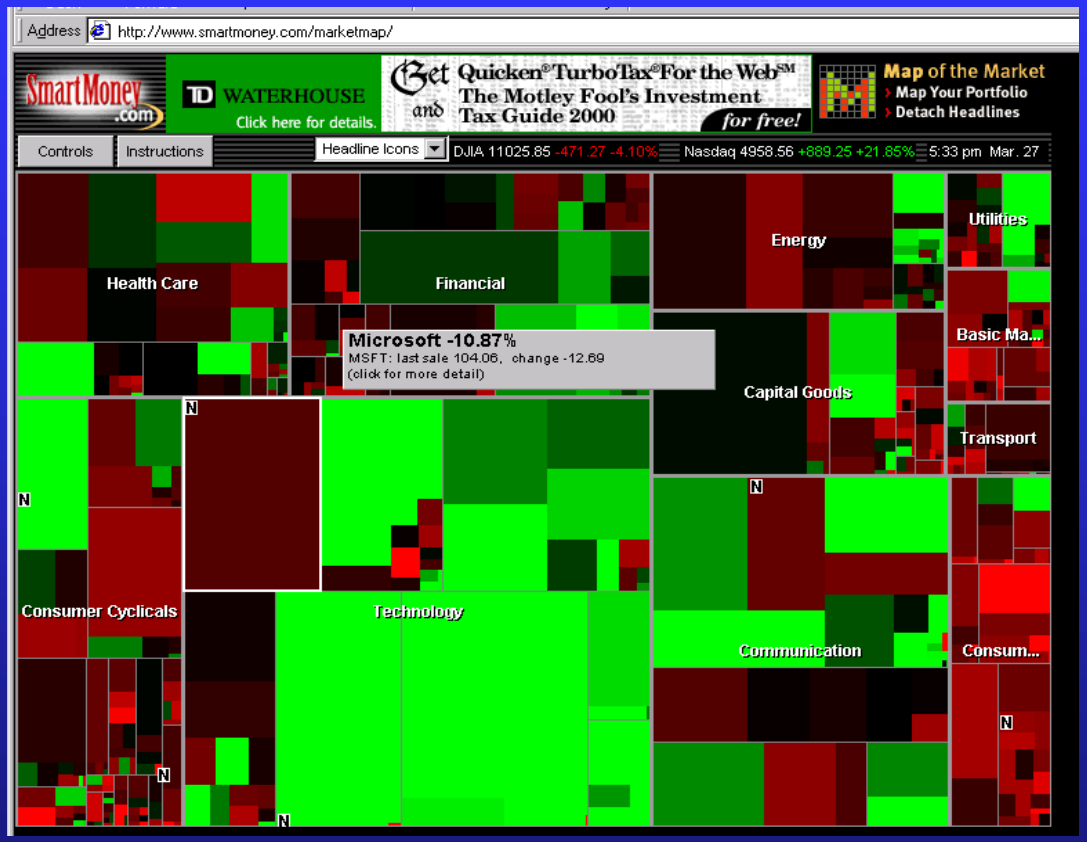
Hyperbolic Tree / Star Tree



Treemap - view large trees with node values

- Space filling
- Space limited
- Color coding
- Size coding

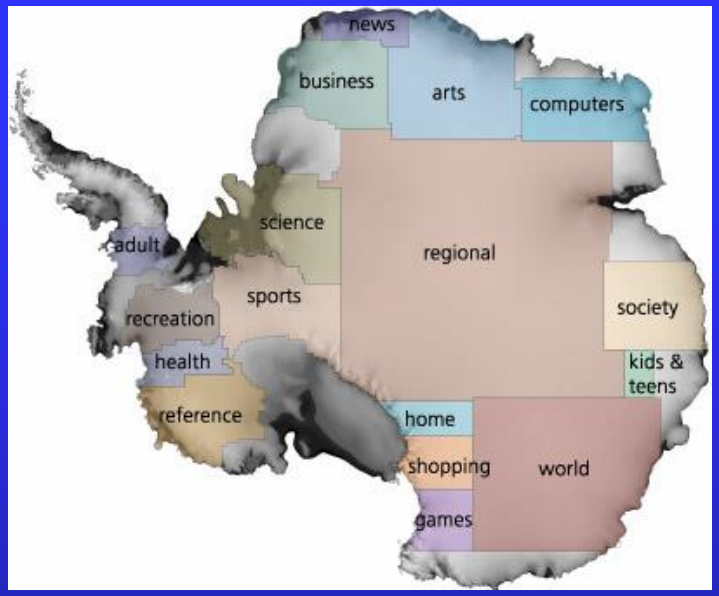
? Requires learning



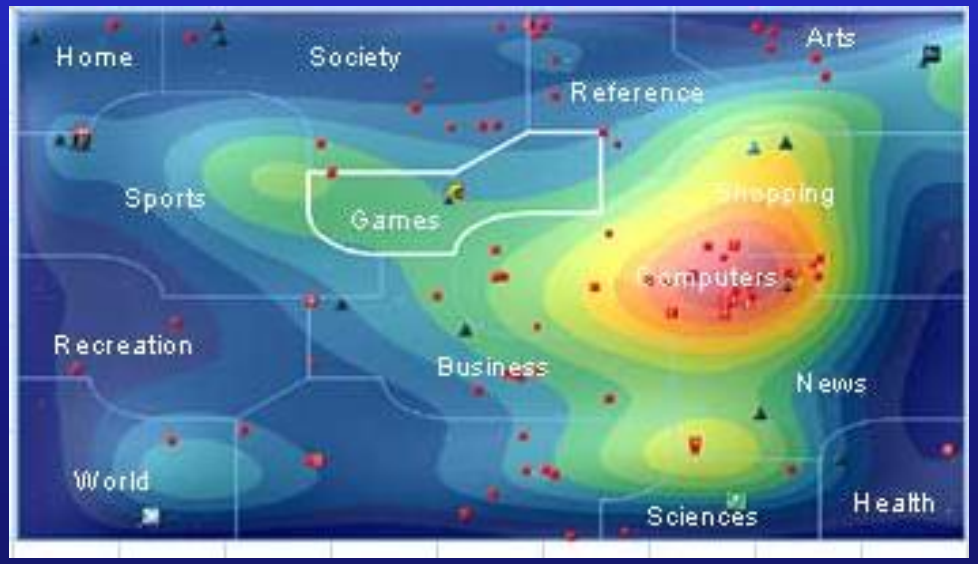
TreeViz (Mac, Johnson, 1992)
NBA-Tree(Sun, Turo, 1993)
Winsurfer (Teittinen, 1996)
Diskmapper (Windows, Micrologic)
Treemap97 (Windows, UMd)

(Shneiderman, *ACM Trans. on Graphics*, 1992)

Treemap – Mapping the Internet



www.map.net



www.webmap.com

One Other Approach to Web Searching

Lighthouse Demo

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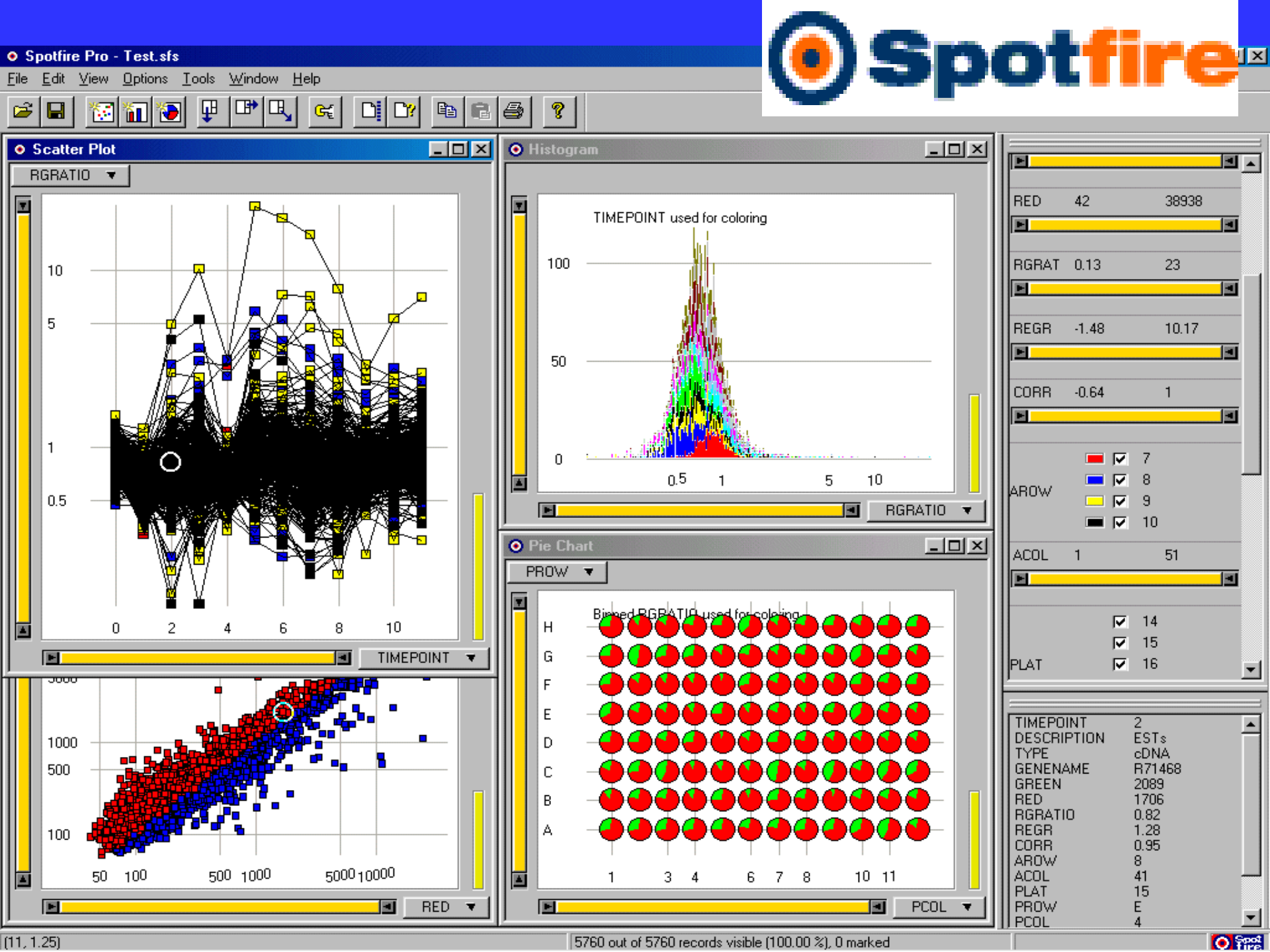
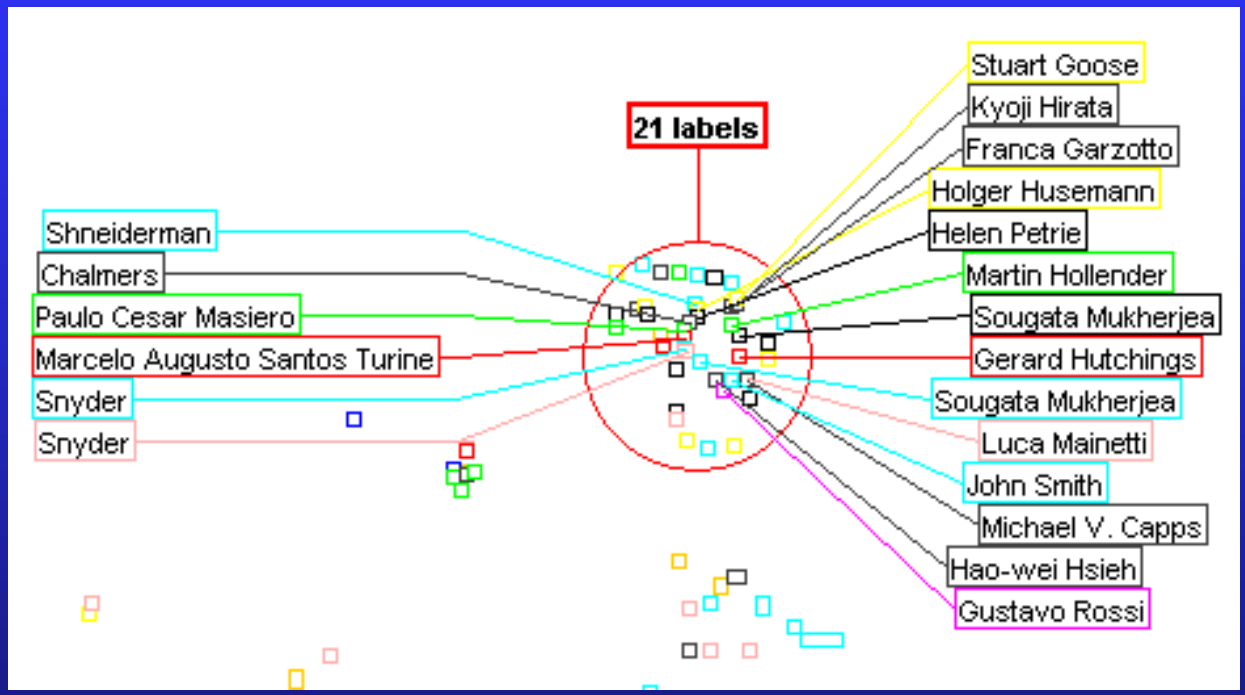

Spotfire Pro - Test.sfs
File Edit View Options Tools Window Help
Spotfire
Scatter Plot
RGRATIO
10
5
1
0.5
0 2 4 6 8 10
TIMEPOINT
1000
500
100
50 100 500 1000 5000 10000
RED
Histogram
TIMEPOINT used for coloring
100
50
0
0.5 1 5 10
RGRATIO
Pie Chart
PROW
Binned RGRATIO used for coloring
H G F E D C B A
1 3 4 6 7 8 10 11
PCOL
RED 42 38938
RGRAT 0.13 23
REGR -1.48 10.17
CORR -0.64 1
AROW 7 8 9 10
ACOL 1 51
PLAT 14 15 16
TIMEPOINT 2
DESCRIPTION ESTs
TYPE cDNA
GENENAME R71468
GREEN 2089
RED 1706
RGRATIO 0.82
REGR 1.28
CORR 0.95
AROW 8
ACOL 41
PLAT 15
PROW E
PCOL 4
(11, 1.25)
5760 out of 5760 records visible (100.00 %), 0 marked

Other Issues: Labeling

- **Eccentric labels and Hover labels / tool tips**

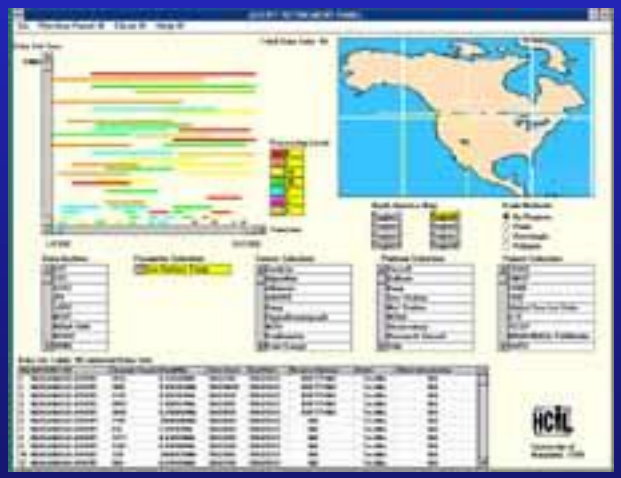


http://www.cs.umd.edu/hcil/excentric/dist/bin/test7.html

Other Issues: Large Data Query

- **Use Query Previews**

  Helps users refine queries and know how big result set is.



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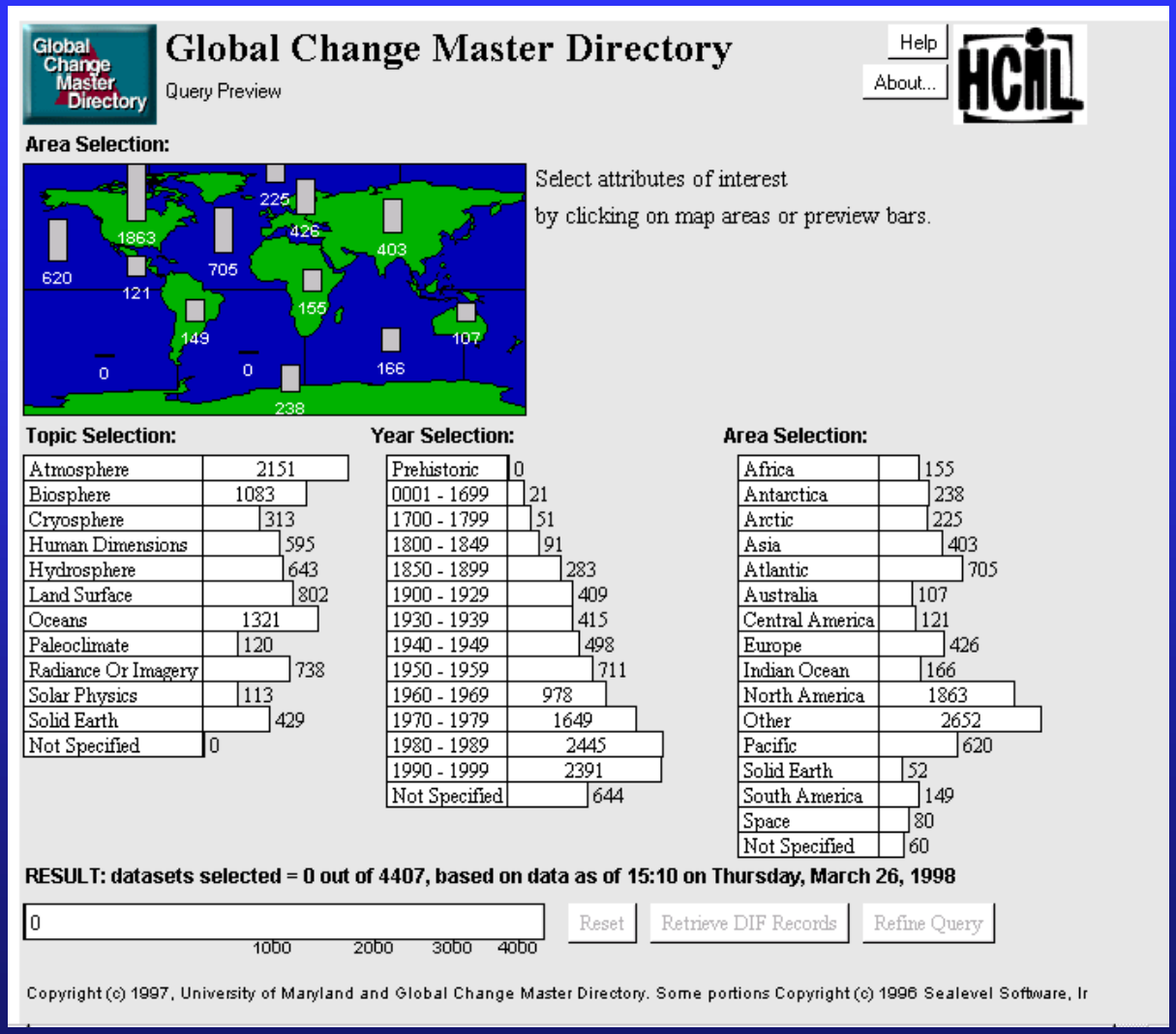

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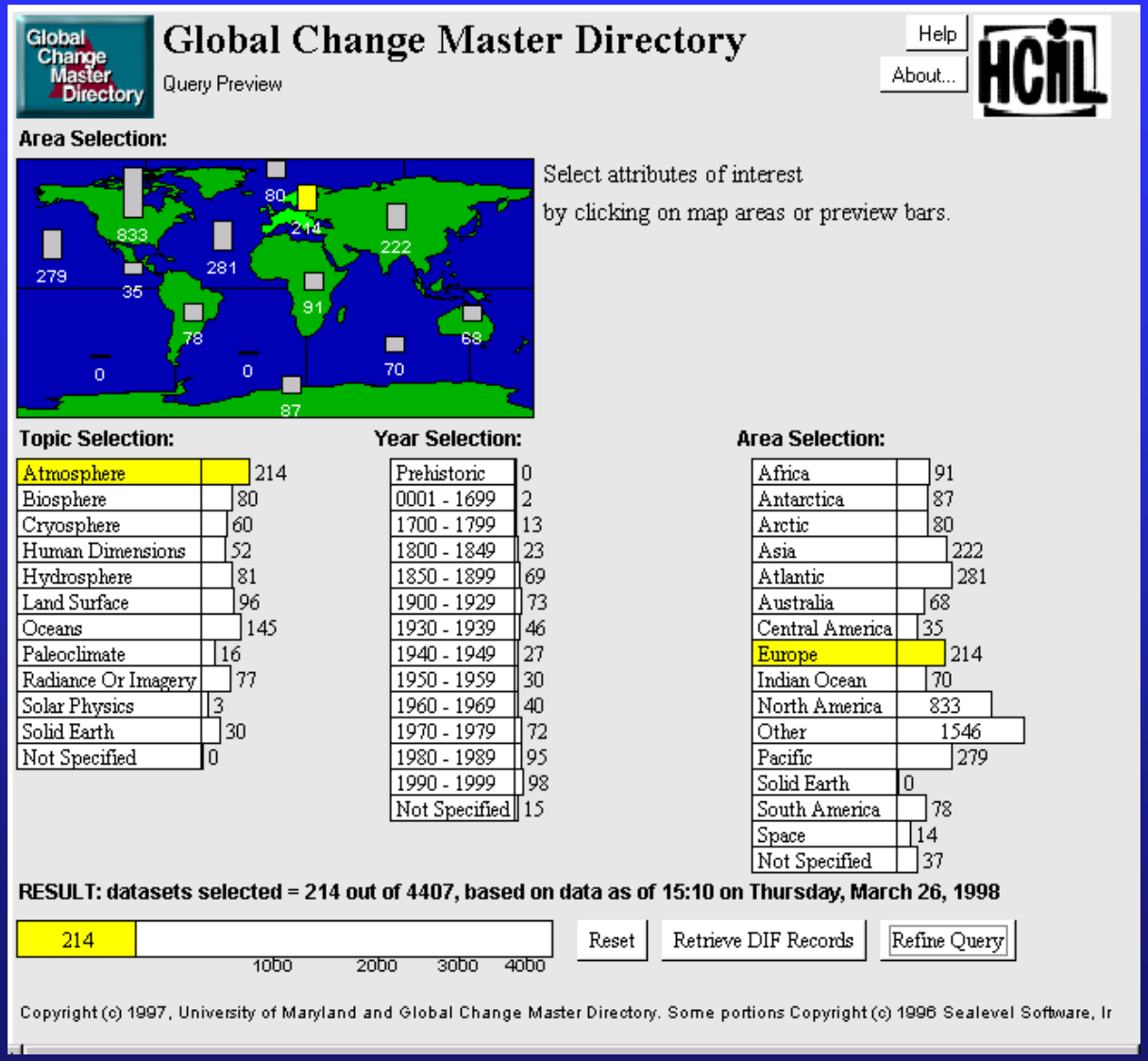

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