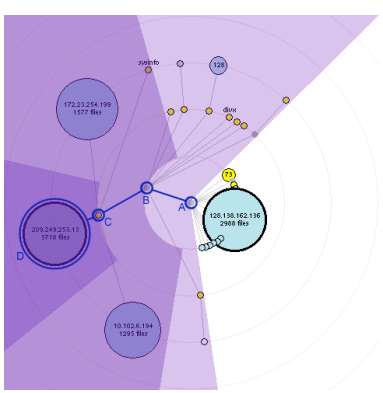
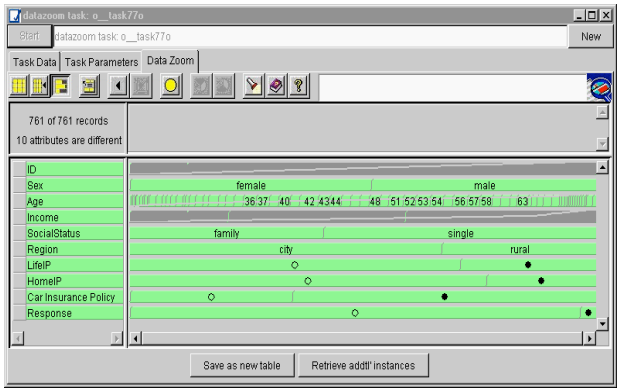
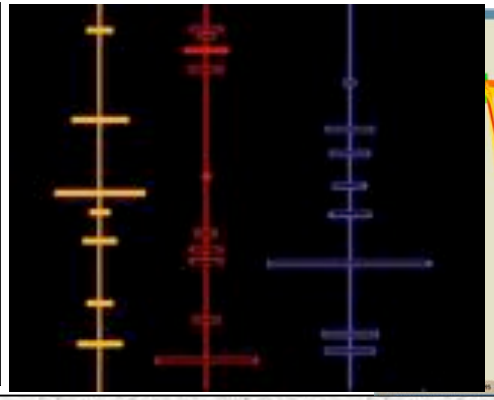
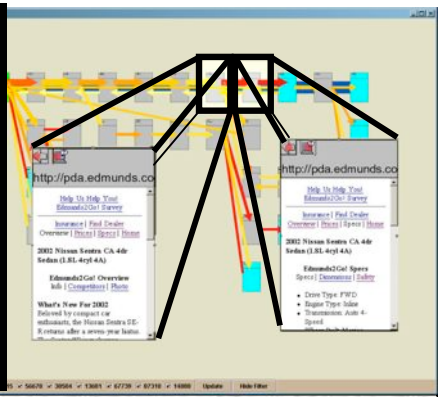
Information Visualization and Presentation

Based on slides from
Marti Hearst and Jeff Heer









What is Information Visualization?

"Transformation of the symbolic into the geometric"
(McCormick et al., 1987)

"... finding the artificial memory that best
supports our natural means of perception."
(Bertin, 1983)

The depiction of information using spatial or graphical representations, to facilitate comparison, pattern recognition, change detection, and other cognitive skills by making use of the visual system (Hearst 03).

Visual Aids for Thinking

- We build tools to amplify cognition.
- Example: multiplication (Card, Moran, & Shneiderman.)
  - In your head, multiply 35 x 95
  - Now do it on paper
  - People are 5 times faster with the visual aid

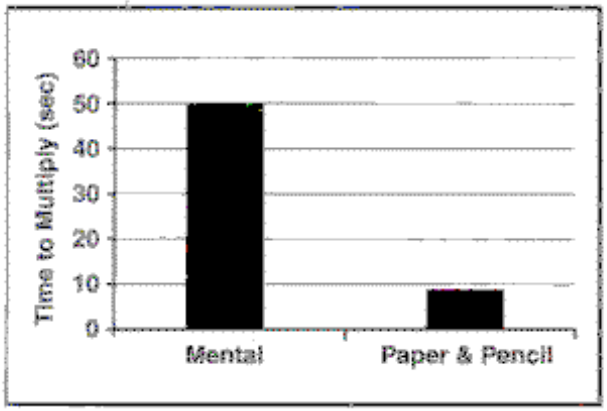
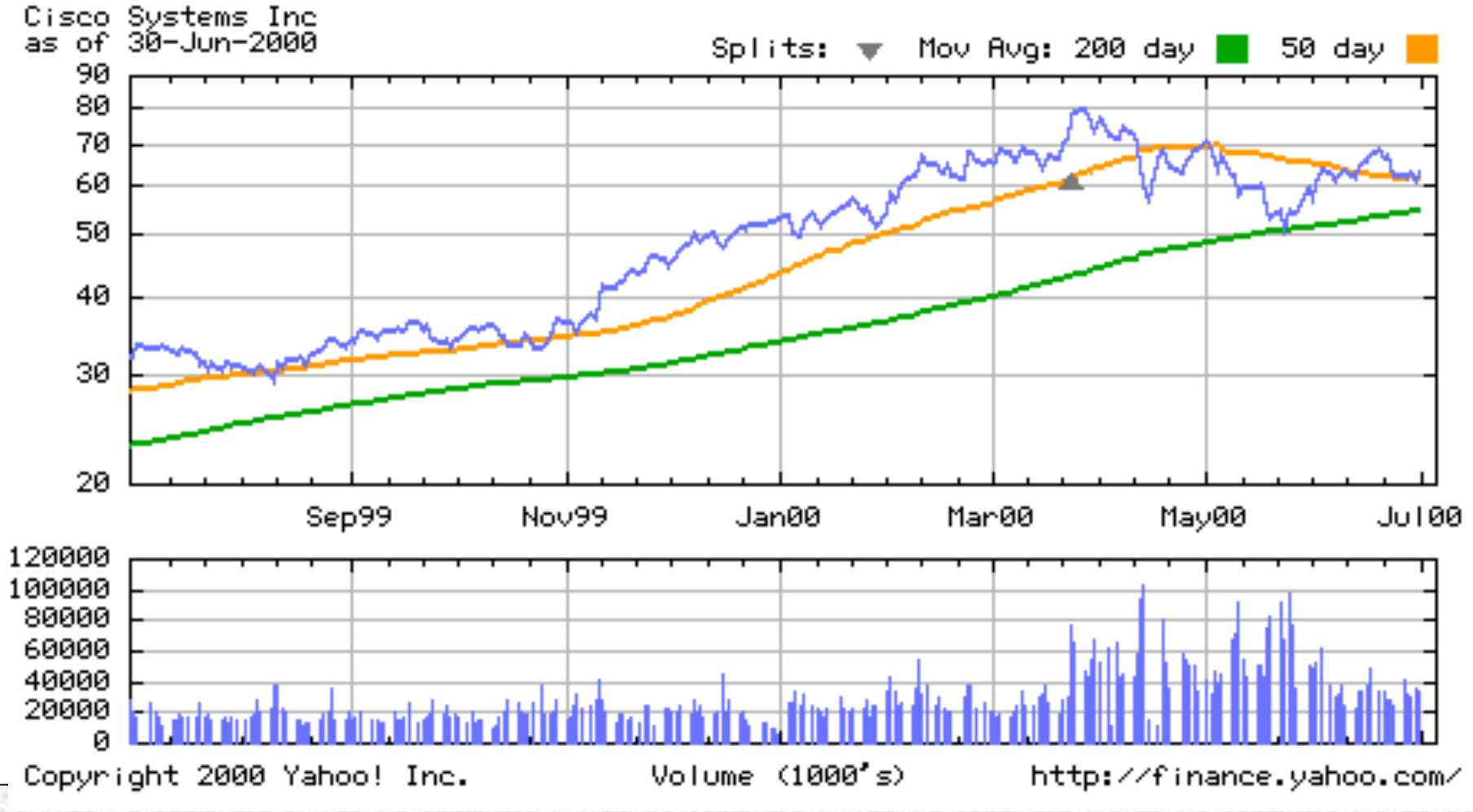


FIGURE 1.1

Use of external aids amplifies ability to do multiplication.

The Power of Visualization

The Power of Visualization



The Power of Visualization

1. **Start out going Southwest on ELLSWORTH AVE**
   Towards BROADWAY by turning right.
2. **Turn RIGHT onto BROADWAY.**
3. **Turn RIGHT onto QUINCY ST.**
4. **Turn LEFT onto CAMBRIDGE ST.**
5. **Turn SLIGHT RIGHT onto MASS**
6. **Turn RIGHT onto RUSSELL ST.**

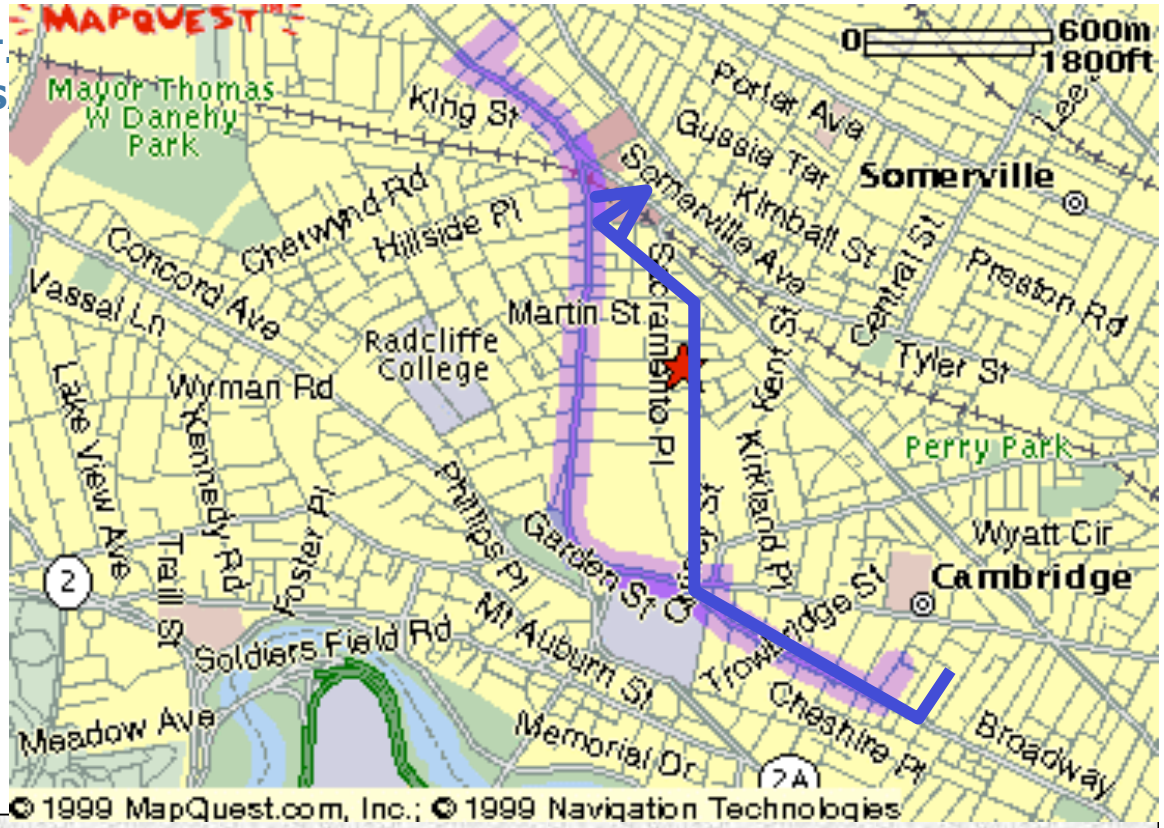
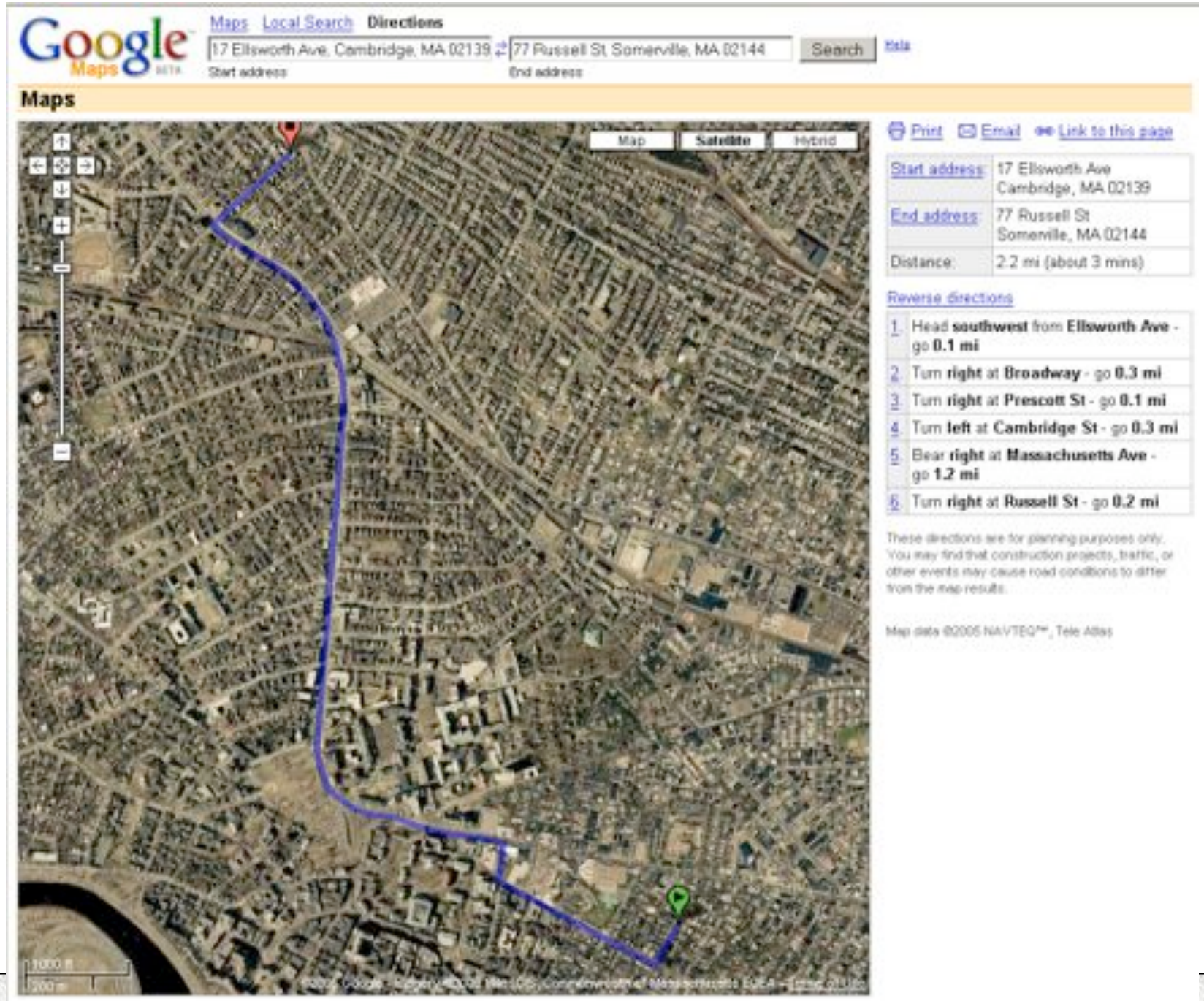


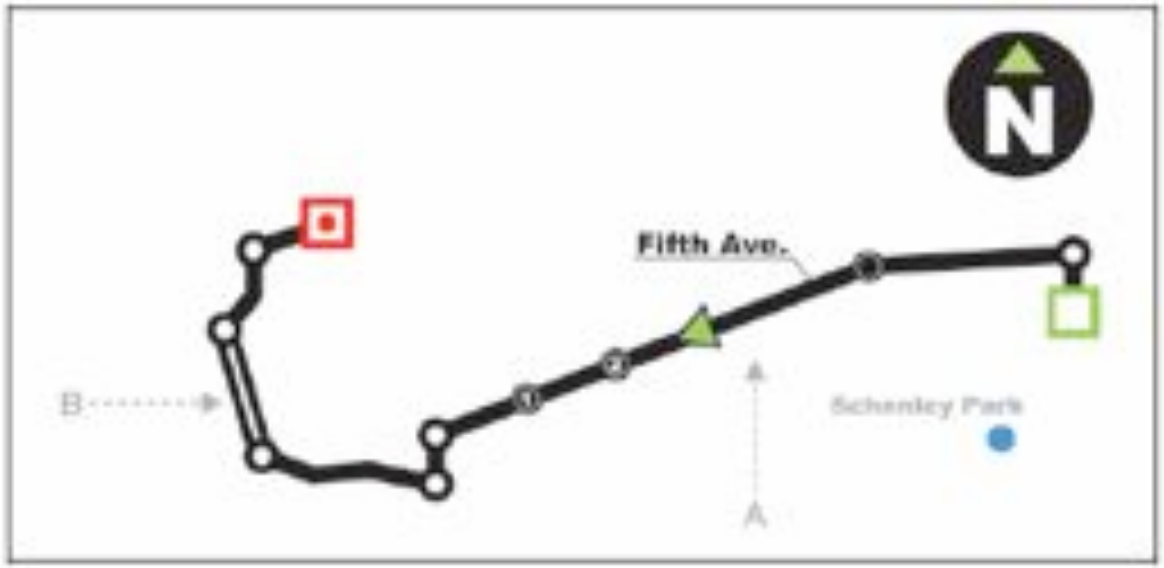
Image from mapquest.com

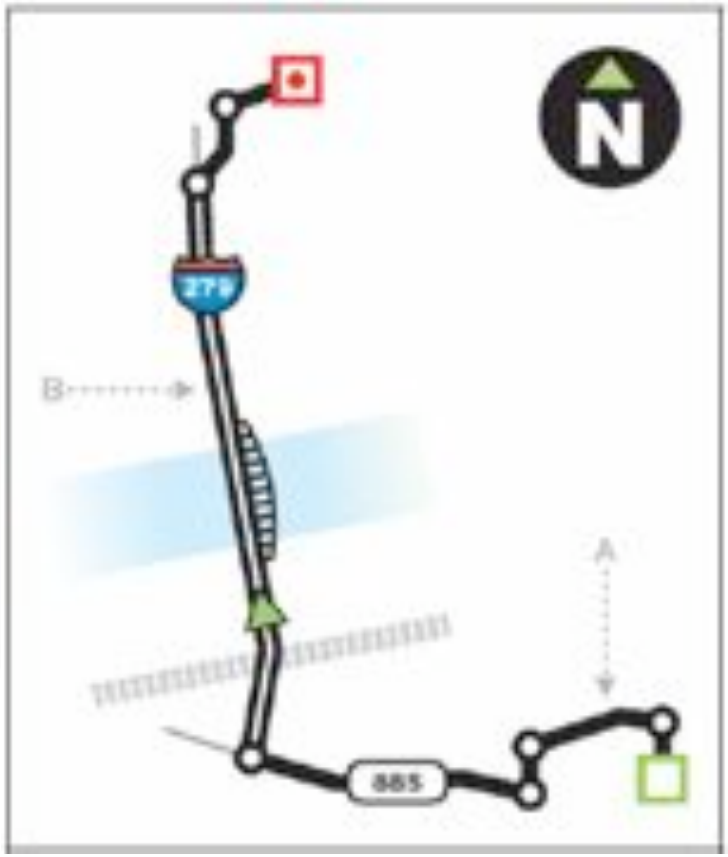

Google Maps
Maps Local Search Directions
17 Ellsworth Ave, Cambridge, MA 02139
Start address
77 Russell St, Somerville, MA 02144
End address
Search
Maps
Map
Satellite
Hybrid
Print
Email
Link to this page
Start address: 17 Ellsworth Ave Cambridge, MA 02139
End address: 77 Russell St Somerville, MA 02144
Distance: 2.2 mi (about 3 mins)
Reverse directions
1. Head southwest from Ellsworth Ave - go 0.1 mi
2. Turn right at Broadway - go 0.3 mi
3. Turn right at Prescott St - go 0.1 mi
4. Turn left at Cambridge St - go 0.3 mi
5. Bear right at Massachusetts Ave - go 1.2 mi
6. Turn right at Russell St - go 0.2 mi
These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.
Map data ©2005 NAVTEQ™, Tele Atlas

The Power of Visualization

LineDrive by Maneesh Agrawala http://graphics.stanford.edu/~maneesh/

MOVE: Maps Optimized for Vehicular Environments





Visualization for Problem Solving

Mystery: what is causing a cholera epidemic in London in 1854?

Visualization for Problem Solving

Illustration of John Snow's deduction that a cholera epidemic was caused by a bad water pump, circa 1854.

Horizontal lines indicate location of deaths.

From Visual Explanations by Edward Tufte, Graphics Press, 1997

Visualization for Problem Solving

Illustration of John Snow's
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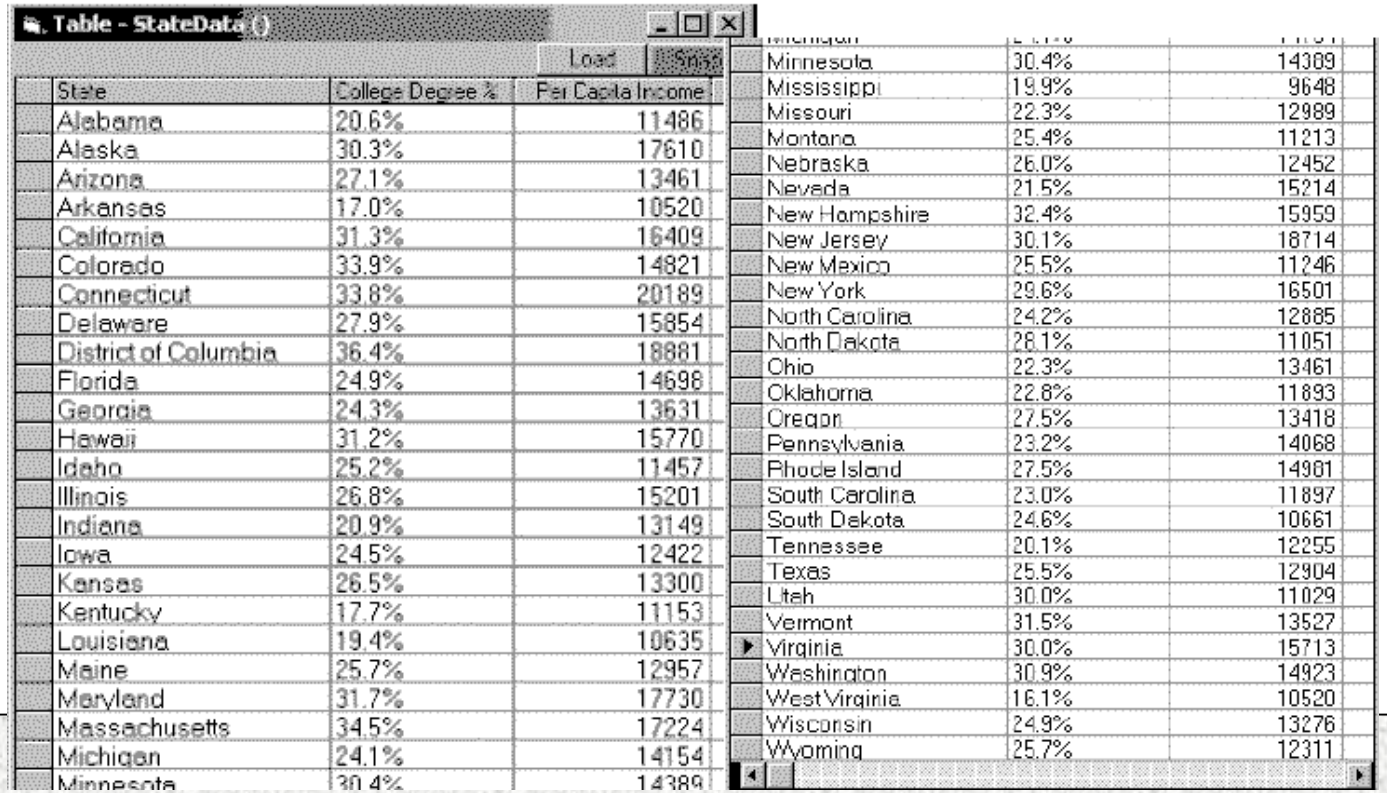
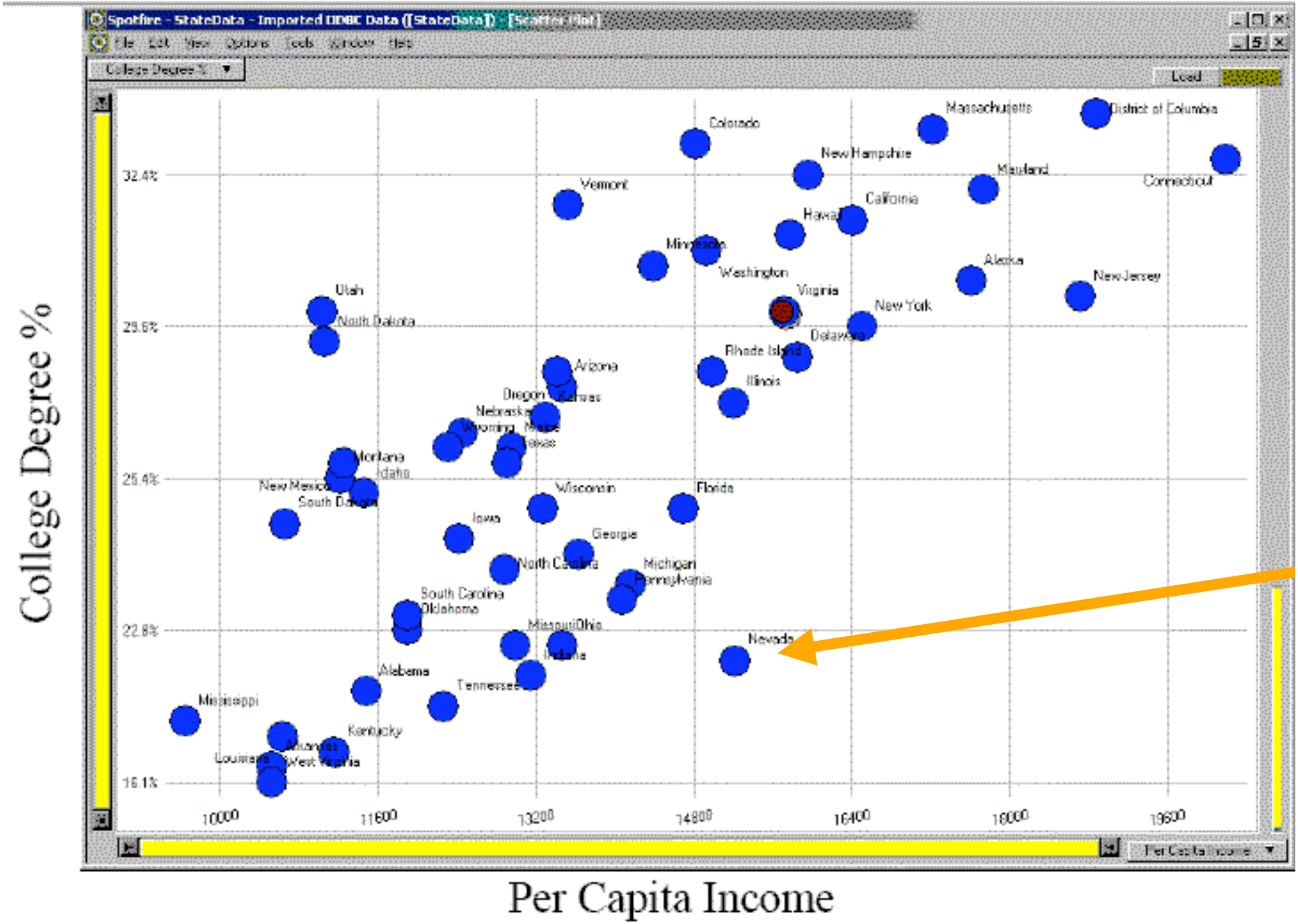
Visualization for Eliciting Knowledge from Data

- Which state has highest Income?
- Relationship between Income and Education?
- Outliers?



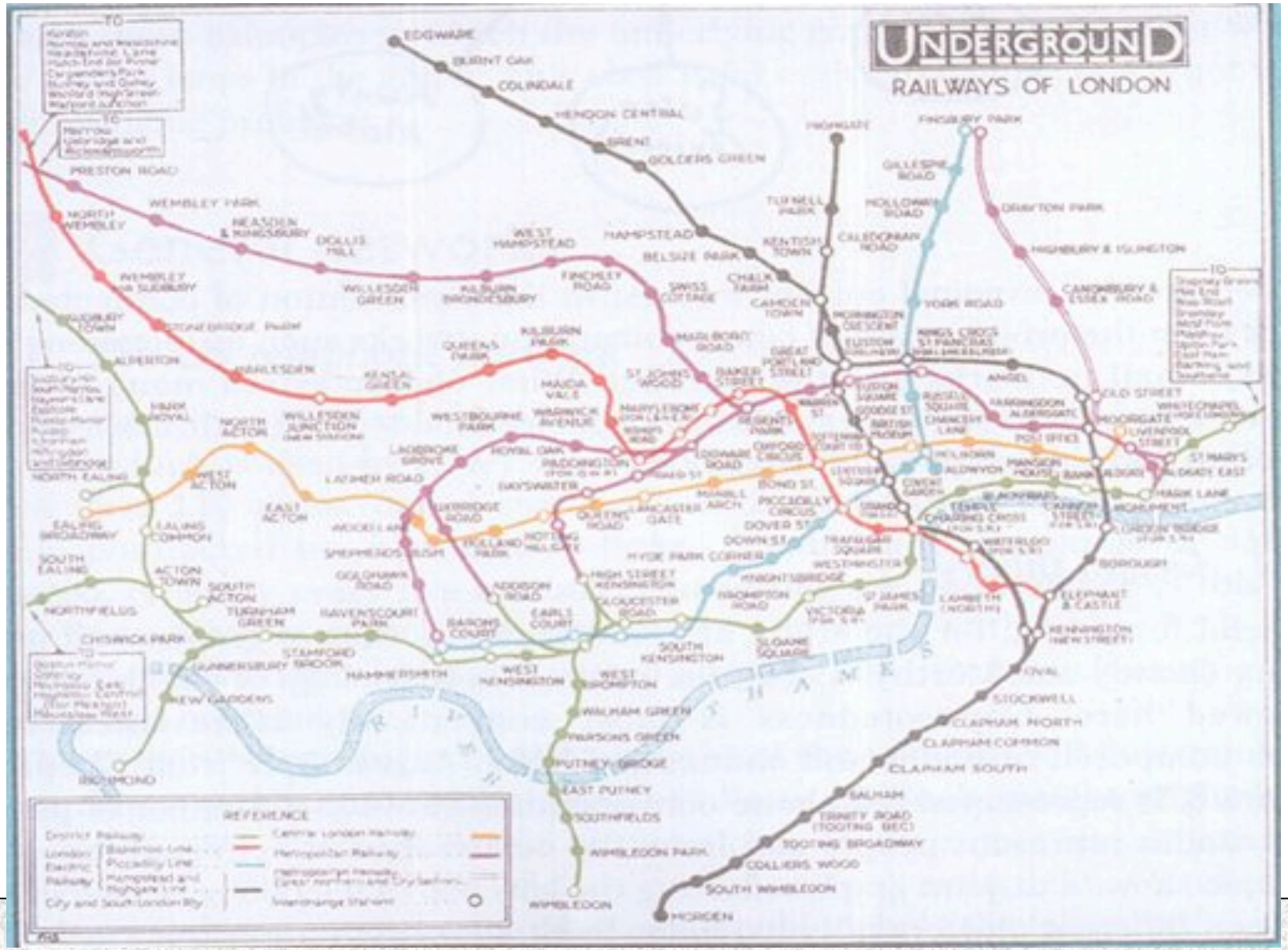
State	College Degree %	Per Capita Income
Alabama	20.6%	11486
Alaska	30.3%	17610
Arizona	27.1%	13461
Arkansas	17.0%	10520
California	31.3%	16409
Colorado	33.9%	14821
Connecticut	33.8%	20189
Delaware	27.9%	15854
District of Columbia	36.4%	18881
Florida	24.9%	14698
Georgia	24.3%	13631
Hawaii	31.2%	15770
Idaho	25.2%	11457
Illinois	26.8%	15201
Indiana	20.9%	13149
Iowa	24.5%	12422
Kansas	26.5%	13300
Kentucky	17.7%	11153
Louisiana	19.4%	10635
Maine	25.7%	12957
Maryland	31.7%	17730
Massachusetts	34.5%	17224
Michigan	24.1%	14154
Minnesota	30.4%	14389
Mississippi	19.9%	9648
Missouri	22.3%	12989
Montana	25.4%	11213
Nebraska	26.0%	12452
Nevada	21.5%	15214
New Hampshire	32.4%	15959
New Jersey	30.1%	18714
New Mexico	25.5%	11246
New York	29.6%	16501
North Carolina	24.2%	12885
North Dakota	28.1%	11051
Ohio	22.3%	13461
Oklahoma	22.8%	11893
Oregon	27.5%	13418
Pennsylvania	23.2%	14068
Rhode Island	27.5%	14901
South Carolina	23.0%	11897
South Dakota	24.6%	10661
Tennessee	20.1%	12255
Texas	25.5%	12904
Utah	30.0%	11029
Vermont	31.5%	13527
Virginia	30.0%	15713
Washington	30.9%	14923
West Virginia	16.1%	10520
Wisconsin	24.9%	13276
Wyoming	25.7%	12311


College Degree %
Per Capita Income
32.4%
29.6%
25.4%
22.8%
16.1%
10000
11600
13200
14800
16400
18000
19600
Massachusetts
District of Columbia
Colorado
New Hampshire
Maryland
Connecticut
Vermont
California
Hawaii
Minnesota
Washington
Alaska
New Jersey
Utah
North Dakota
Virginia
New York
Delaware
Rhode Island
Arizona
Illinois
Oregon
Kansas
Nebraska
Wyoming
Maine
Texas
Montana
Idaho
New Mexico
South Dakota
Wisconsin
Florida
Iowa
Georgia
North Carolina
Michigan
Pennsylvania
South Carolina
Oklahoma
Missouri
Ohio
Indiana
Nevada
Alabama
Tennessee
Mississippi
Kentucky
Louisiana
West Virginia

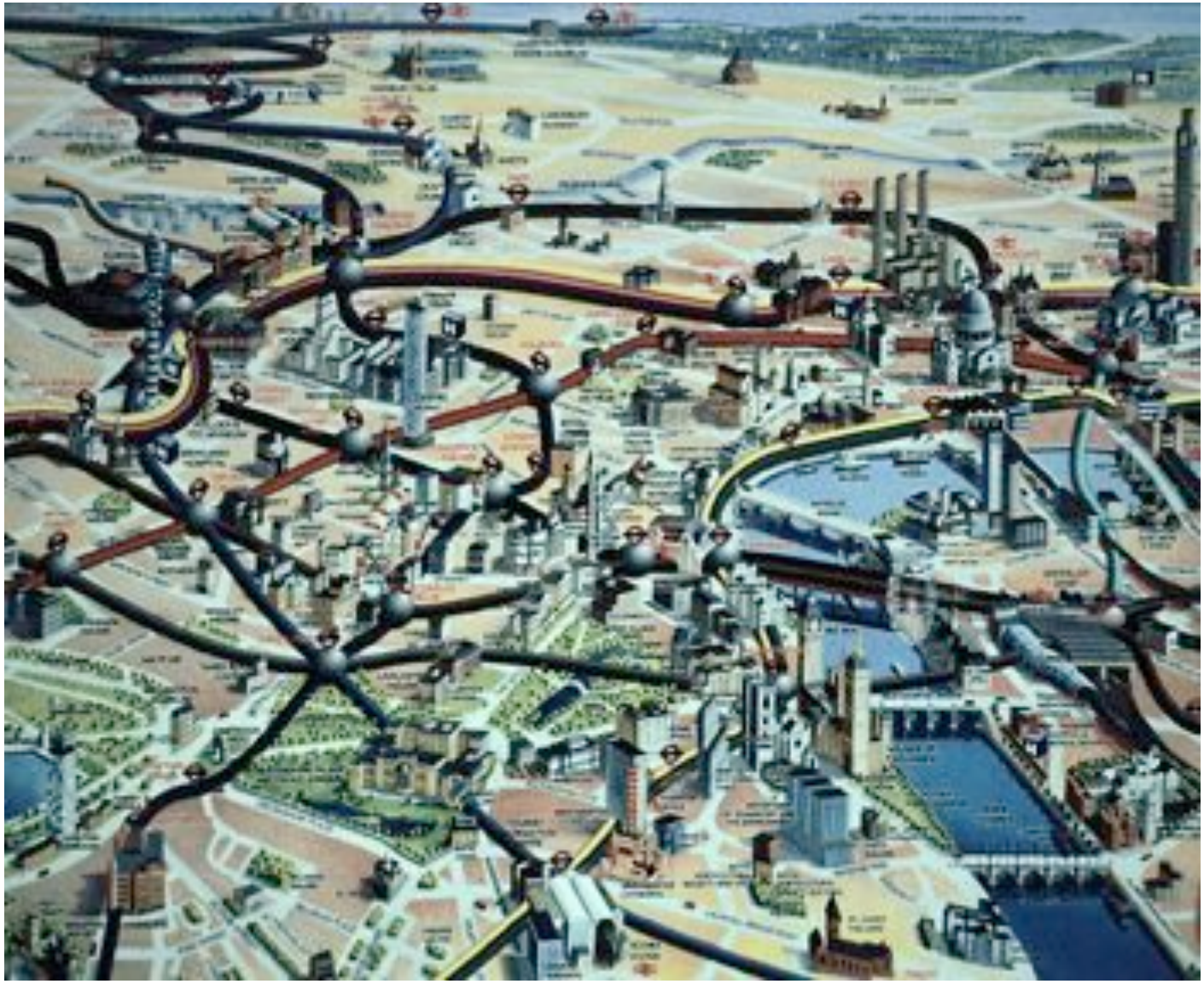
Visualization for Clarification

- London Subway Map Example
- Abstract away details for easier understanding

London Underground Map 1927



London Underground Map 1990s



From http://www.ideography.co.uk/

Two Different Primary Goals: Two Different Types of Viz

Explore / Calculate

- Analyze
- Reason about Information

Communicate

- Explain
- Make Decisions
- Reason about Information

Goals of Information Visualization

In more detail, visualization should:

- Make large datasets coherent
  (Present huge amounts of information compactly)
- Present information from various viewpoints
- Present information at several levels of detail
  (from overviews to fine structure)
- Support visual comparisons
- Tell stories about the data

Human Perceptual Facilities

Use the eye for pattern recognition; people are good at

- scanning
- recognizing
- remembering images

Graphical elements facilitate comparisons via

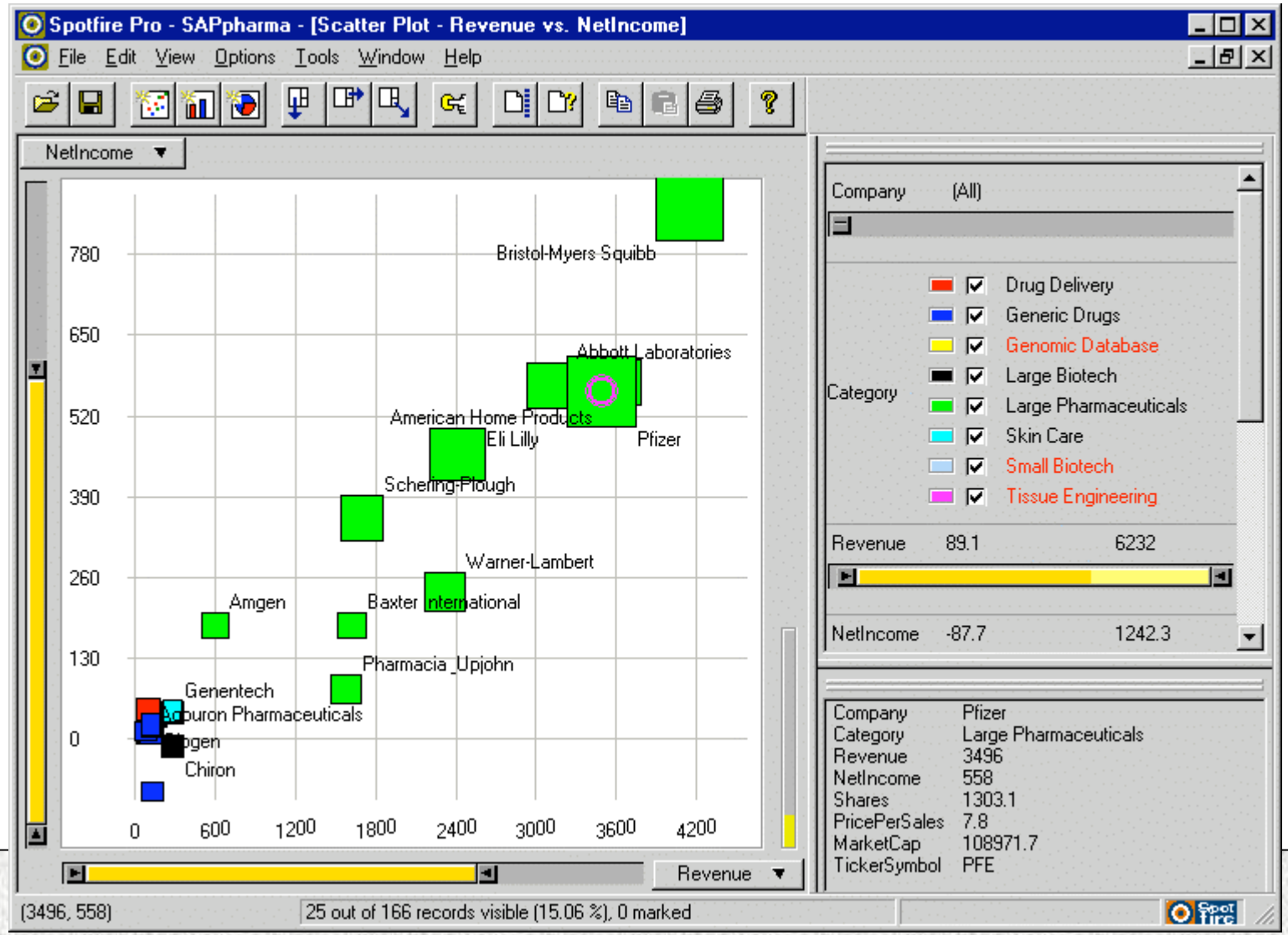
- length
- shape 
- orientation 
- texture 

Animation shows changes across time

Color helps make distinctions

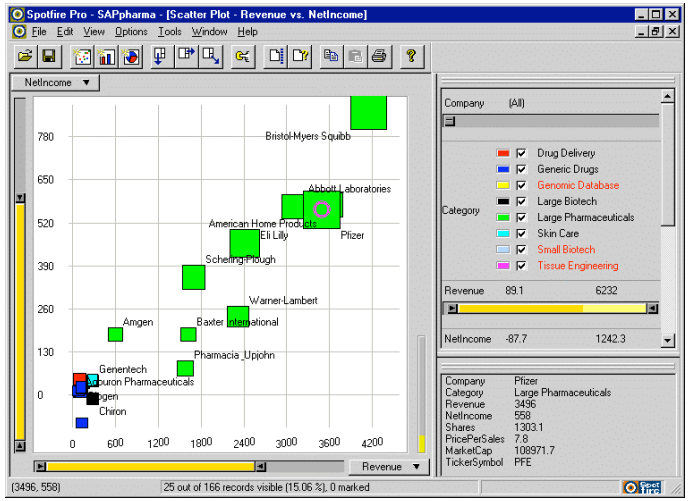
Aesthetics make the process appealing

Example #1: SpotFire



Key Ideas in SpotFire

- Fast filtering via sliders
- Zooming (screen real estate)
- Multiple variables
  - x,y axis, object shape + color
- Details on demand



- Commercialized by SpotFire Inc, used heavily by pharmaceuticals

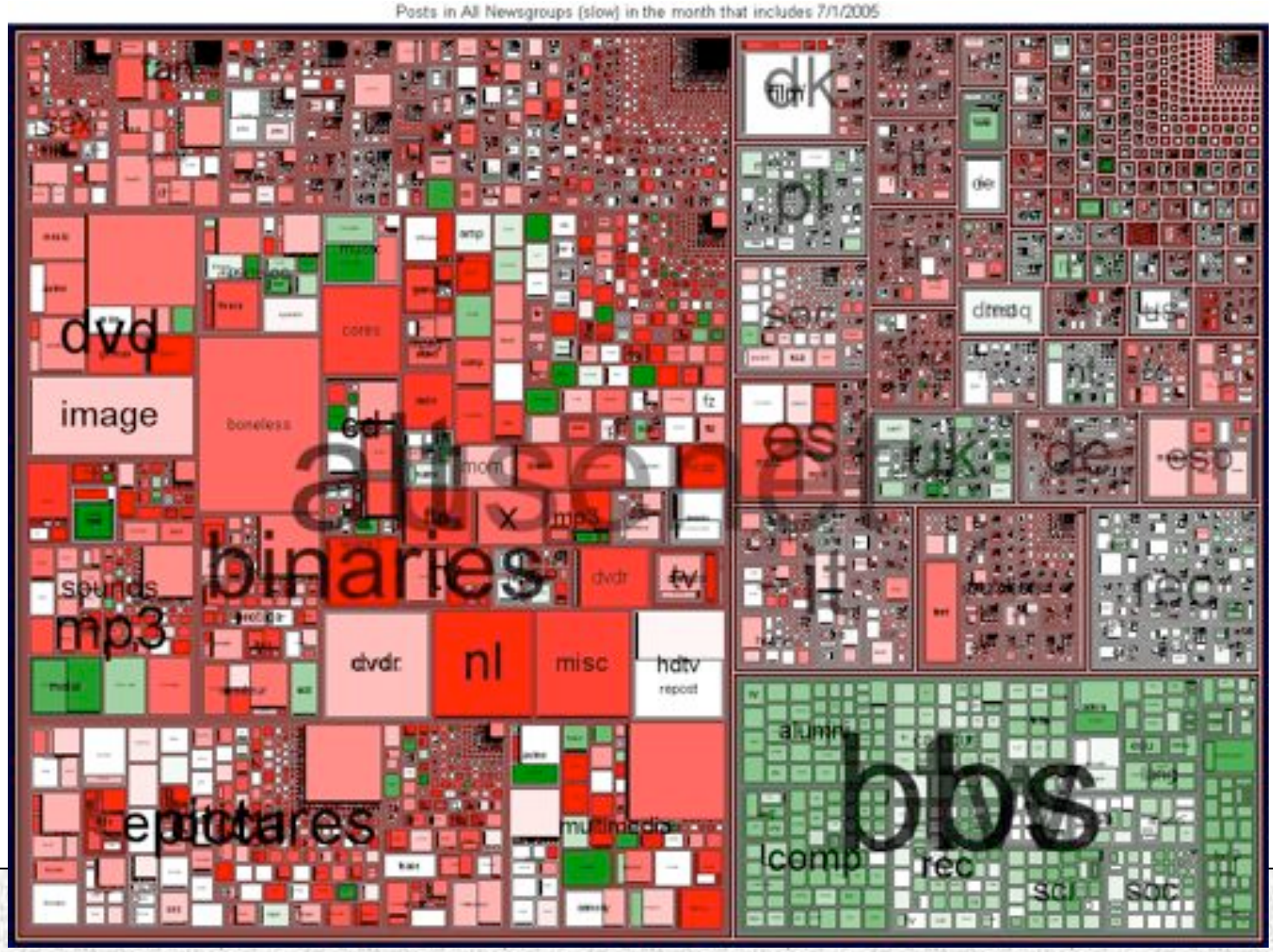
Example #2: Table Lens

Key Ideas in Table Lens

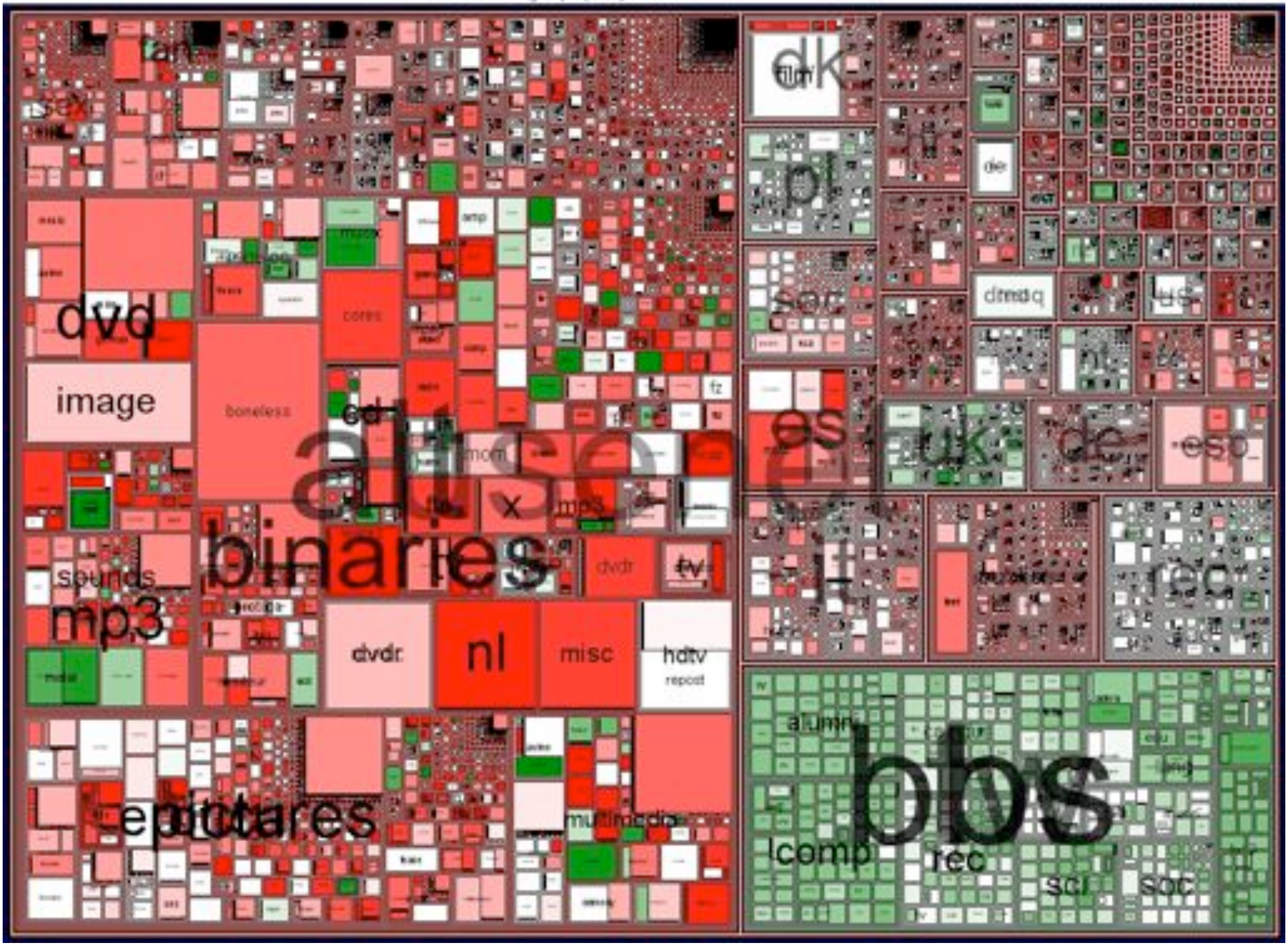
- Fast sorting (and linked views)
- Re-arrange columns
- Focus on a subset of data
- Easy filtering

- Table Lens now a product by Inxight

Example 3: Tree Maps



Posts in All Newsgroups (slow) in the month that includes 7/1/2005



Case Study:
The Journey of the TreeMap

- The TreeMap **(Johnson & Shneiderman '91)**
- Idea:
  - Show a hierarchy as a 2D layout
  - Fill up the space with rectangles representing objects
  - Nested rectangles indicated levels of hierarchy
  - Size on screen indicates relative size of underlying objects.

Case Study:
The Journey of the TreeMap

(Johnson & Shneiderman '91)

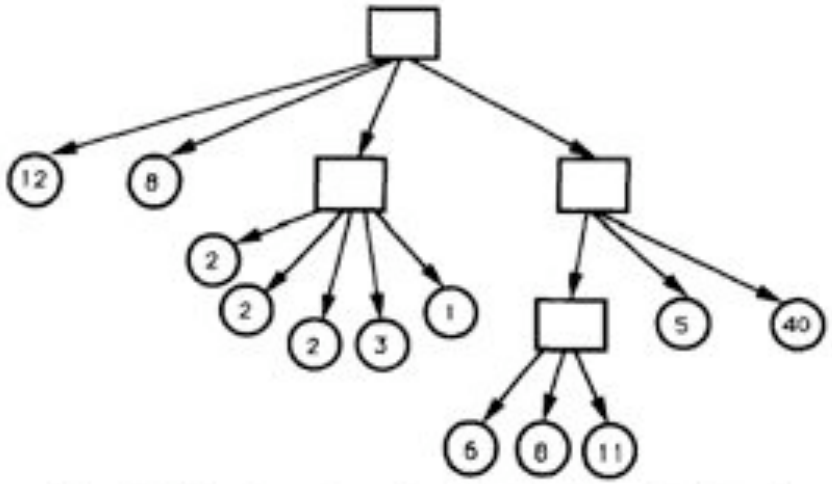


Fig. 1. Typical 3-level tree structure with numbers indicating size of each leaf node.

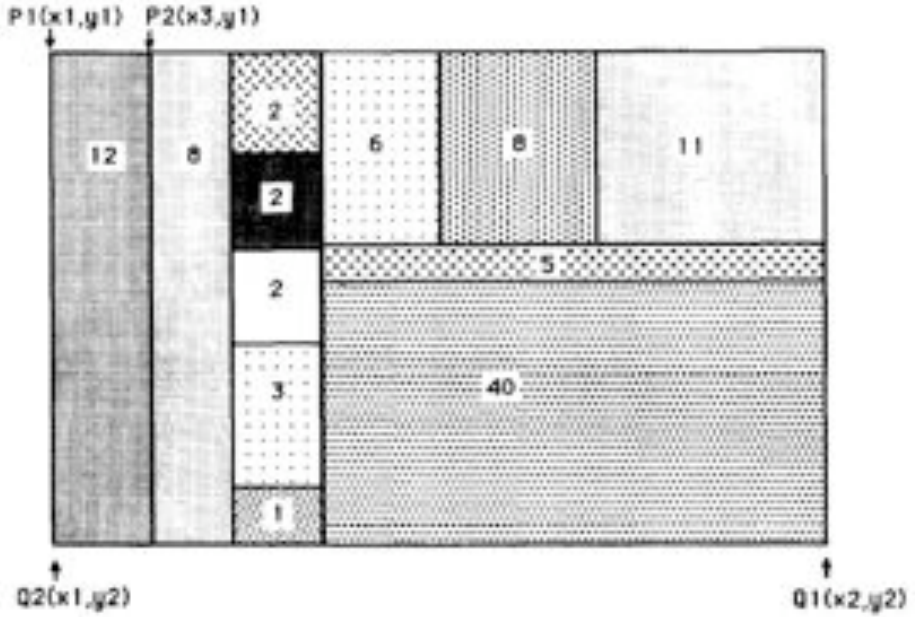


Fig. 2. Tree-map of Figure 1.

(Johnson & Shneiderman '91)

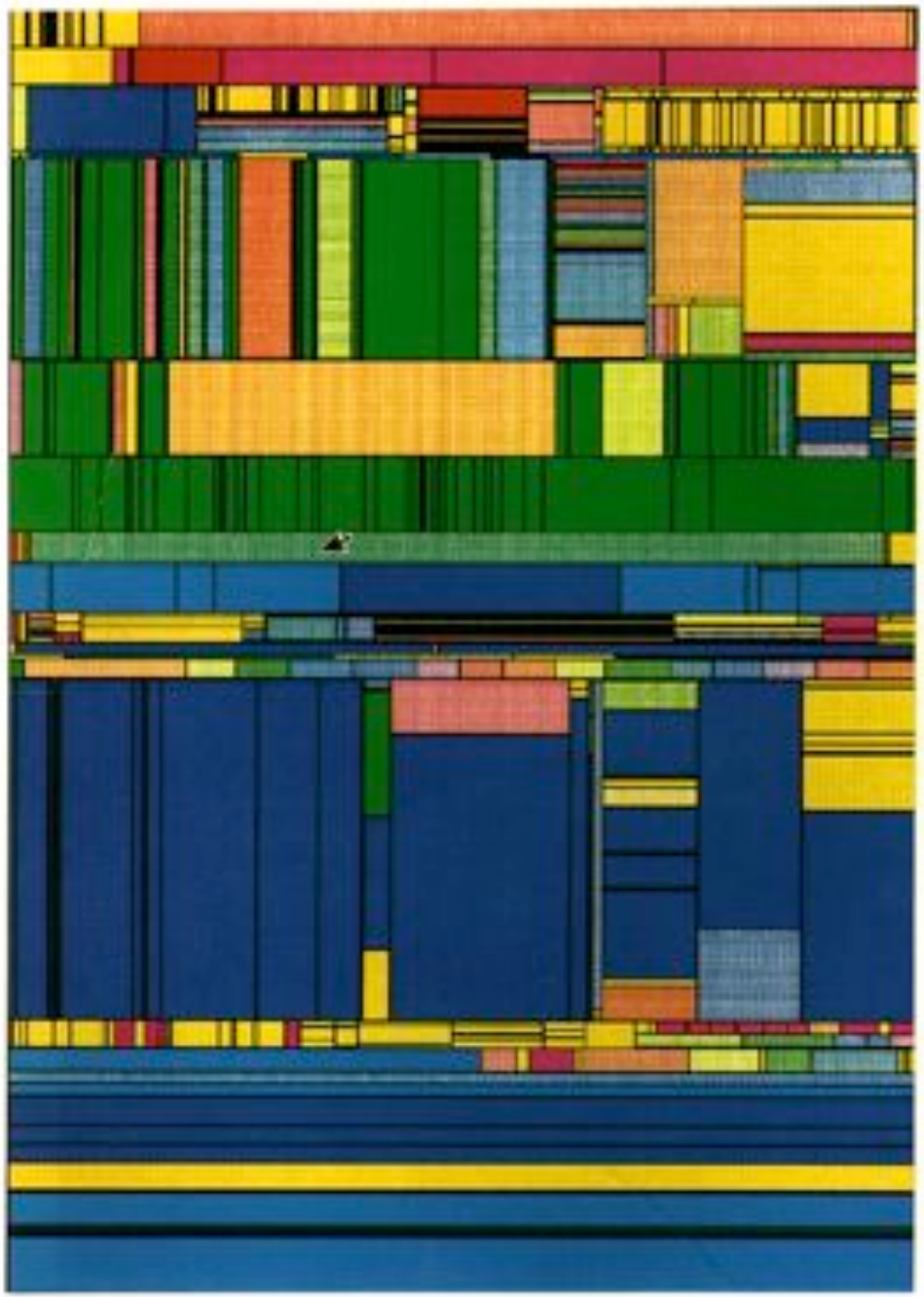
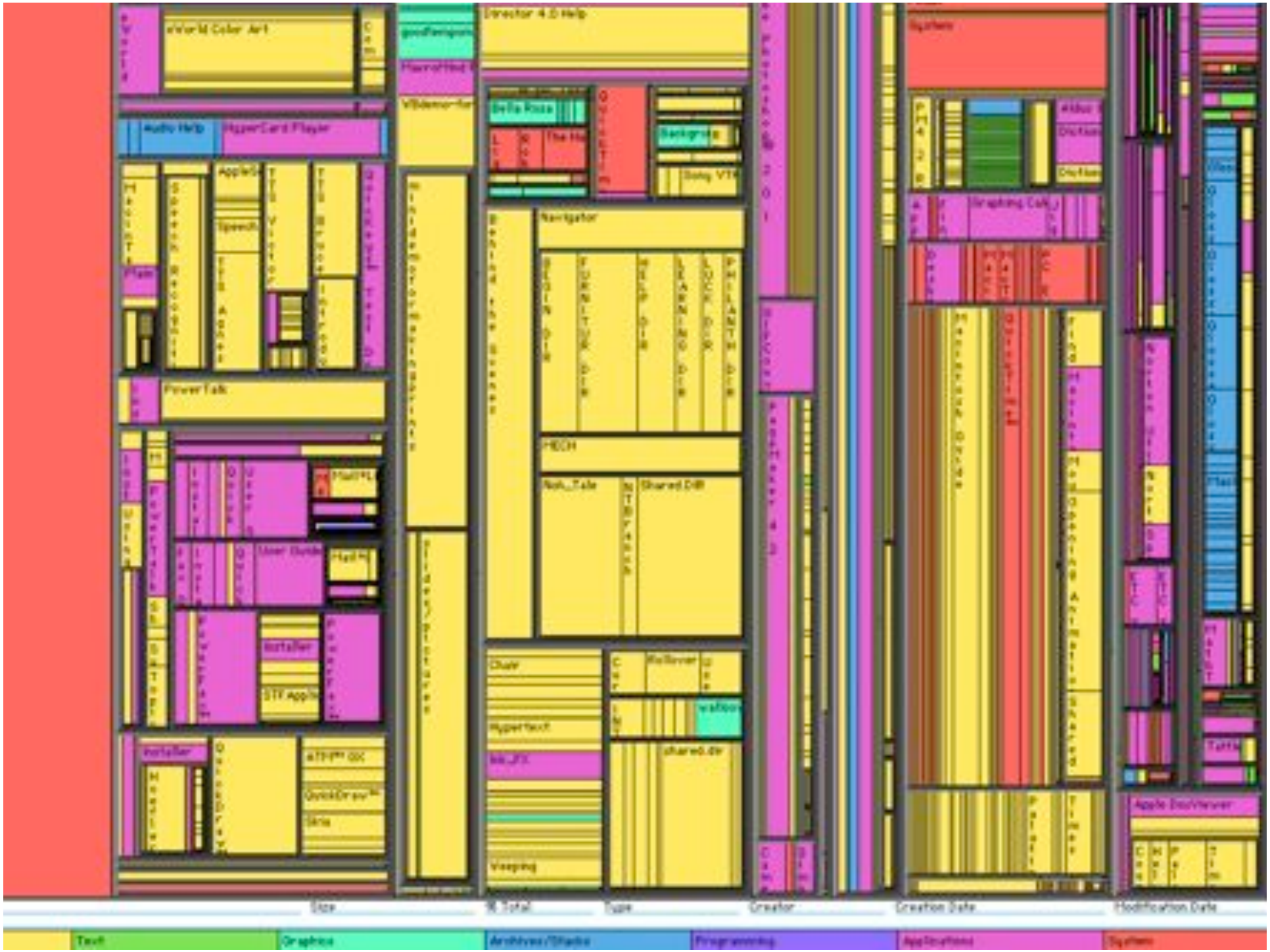


Fig. 4. 850 files at four levels with color coding by file type. File name pops up when cursor rests on a file.


Size
% Total
Type
Creator
Creation Date
Modification Date
Text
Graphics
Archives/Utilities
Programming
Applications
System

Treemap Problems

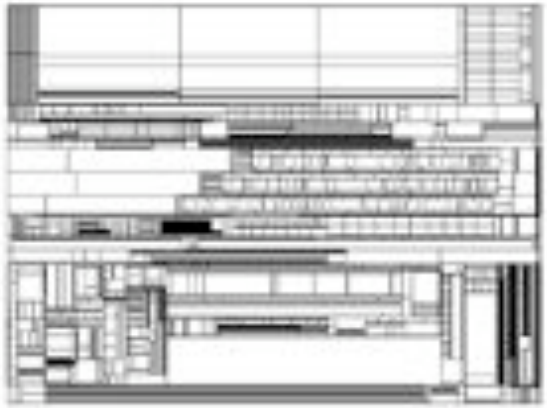
- Too disorderly
  - What does adjacency mean?
  - Aspect ratios uncontrolled leads to lots of skinny boxes that clutter
- Hard to understand
  - Must mentally convert nesting to hierarchy descent
- Color not used appropriately
  - In fact, is meaningless here
- Wrong application
  - Don’t need all this to just see the largest files in the OS

Successful Application of Treemaps

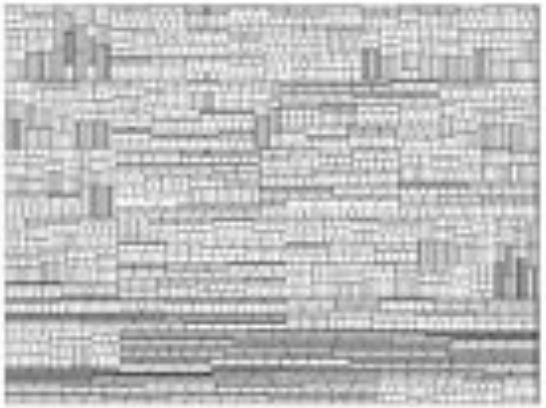
- Think more about the use
  - Break into meaningful groups
- Make appearance more usable
  - Fix these into a useful aspect ratio
  - Do not use nesting recursively
- Use visual properties properly
  - Use color to distinguish meaningfully
    - Use only two colors:
      - Can then distinguish one thing from another
    - When exact numbers aren't very important
- Provide interactivity
  - Access to the real data
  - Makes it into a useful tool

Squarified Treemaps

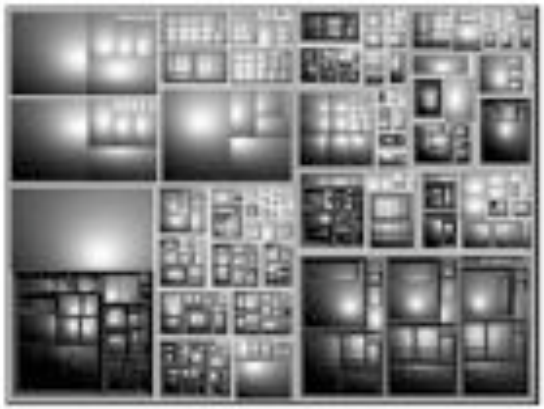
Bruls, Huizing, van Wijk, 1999



(a) File system



(b) Organization



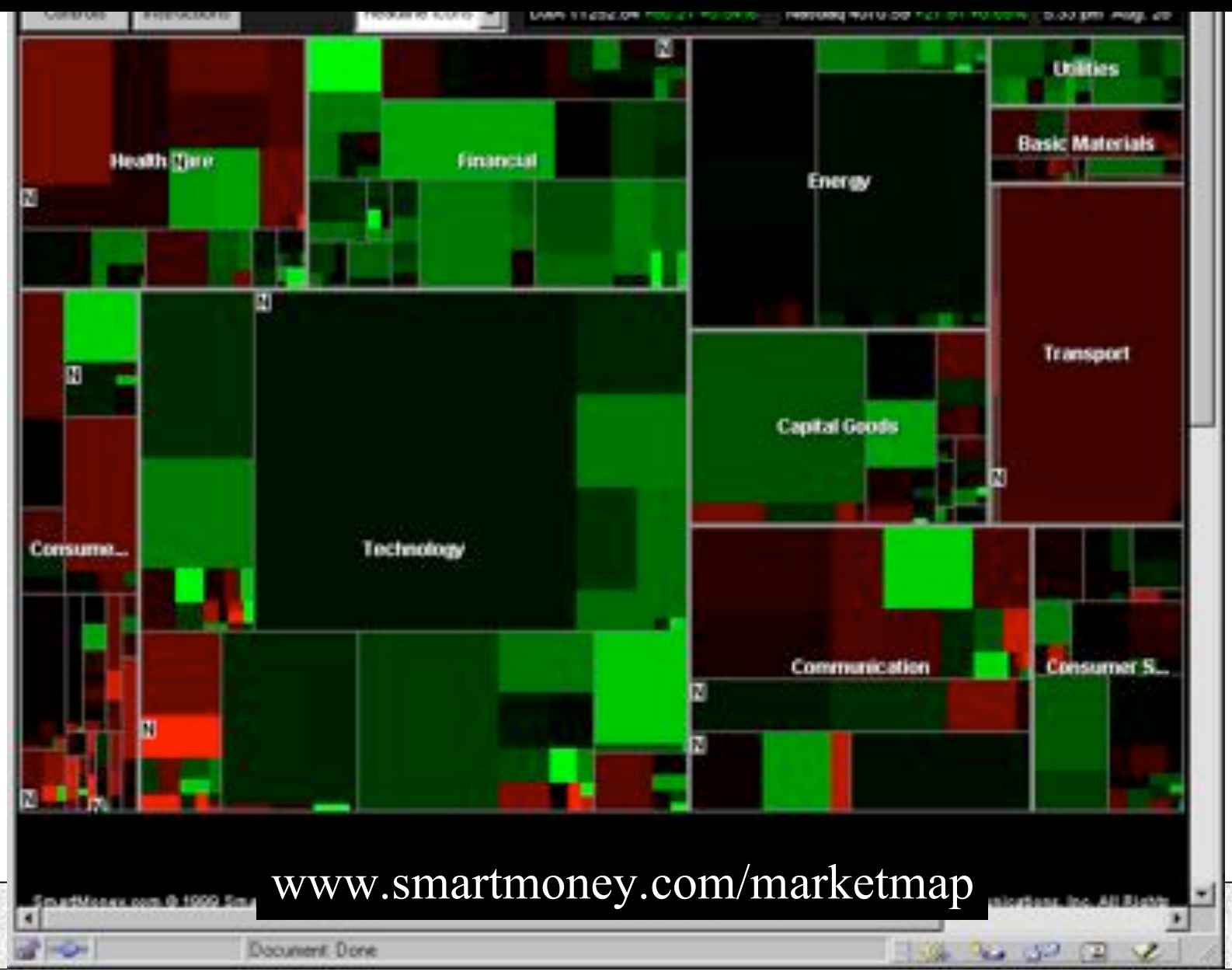
(a) File system

(b) Organization

Improved, Usable TreeMaps

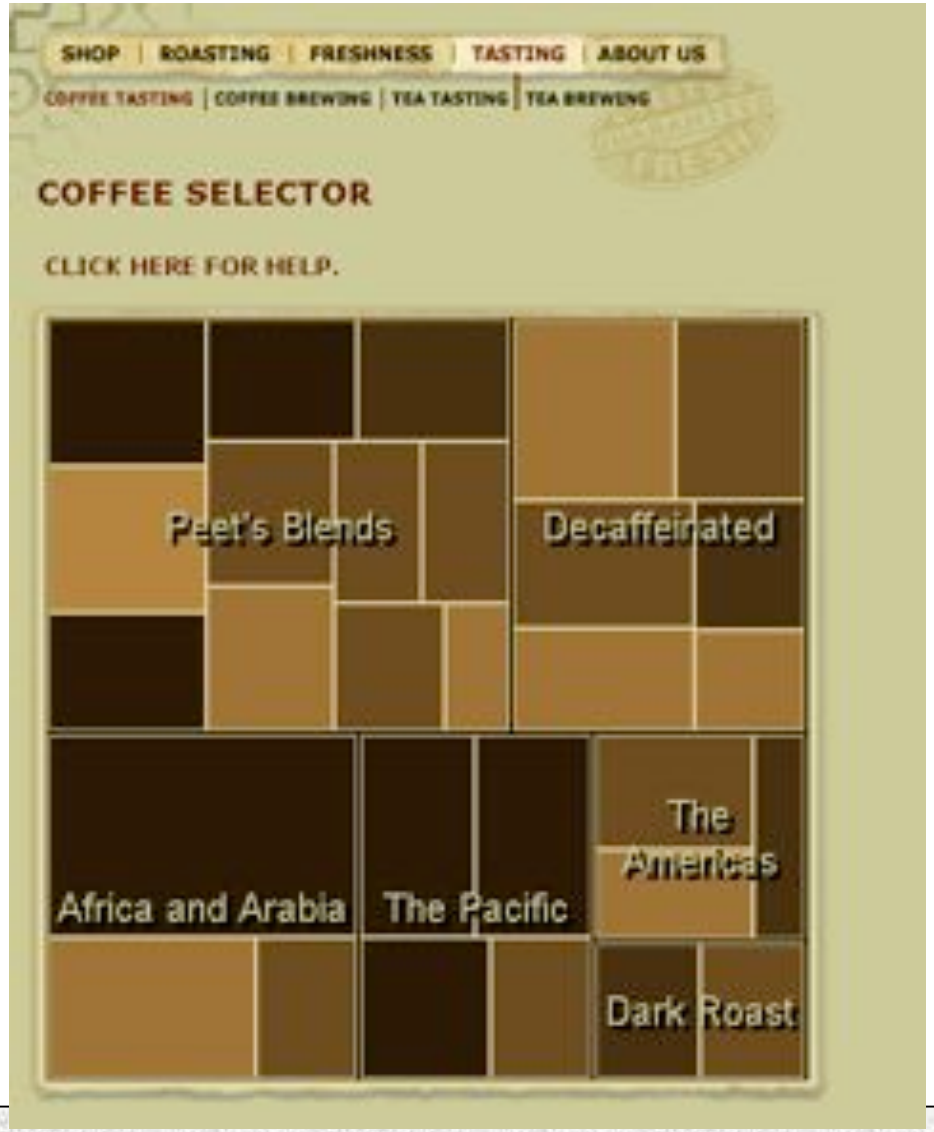
- Analysis:
  - http://www.smartmoney.com/maps
- Communication:
  - http://www.peets.com/selector_coffee/coffee_selector.asp

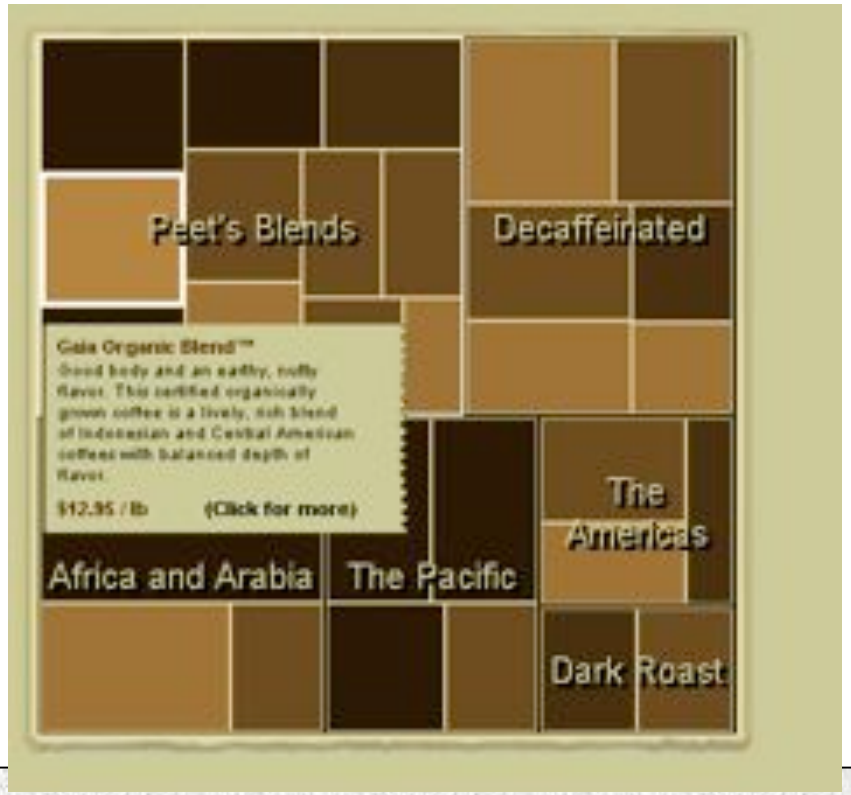
A Good Use of TreeMaps and Interactivity



www.smartmoney.com/marketmap

Treemaps in Peets site



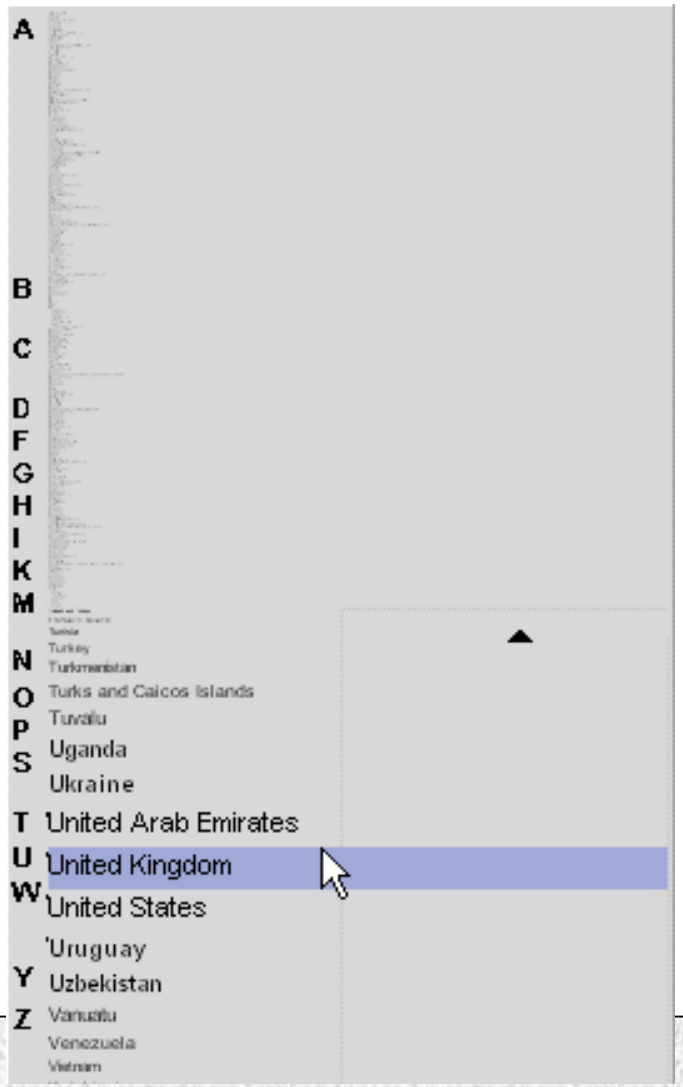


Analysis vs. Communication

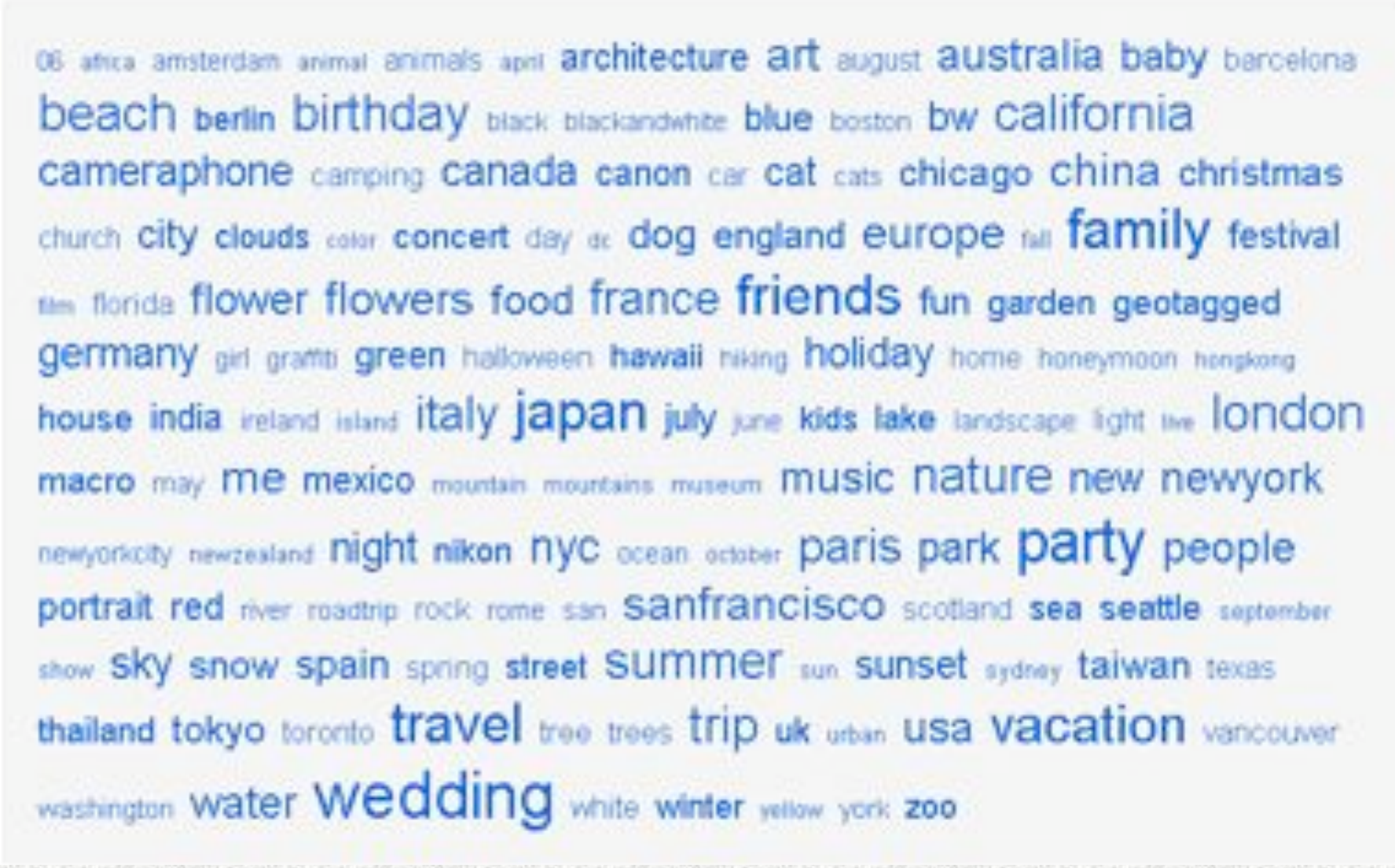
- MarketMap's use of TreeMaps allows for sophisticated analysis
- Peets' use of TreeMaps is more for presentation and communication
- This is a key contrast


http://www.labescape.com - Demos: Nasdaq 100 - AWT - Microsoft Internet Explorer
LAB ESCAPE
Nasdaq 100 - AWT
Ebay Inc (EBAY)
Industry: Technology
Sector: Computer Services
Shares: 661,021 M
Market Cap: 59,976,294 M
Prev Close: 90.1
Last Trade: 89.22
Change: -0.88 (-0.977%)
Volume: 7,366,129
Beta: 1.651
92.00
91.00
90.00
89.00
88.00
5-Day Close
Size
Last Trade
Color
% Change
Chart
5-Day Close
Theme
Red/Green
Technology
MXIM
XLNX
BRCM
MRVL
LLTC
MCHP
LRCX
INTC
KLAC
NVLS
ALTR
ISIL
AMAT
NVDA
AAPL
DELL
SNDK
QLGC
NTAP
CSCO
JNPR
RIMM
QCOM
SYMC
ADBE
INTU
ERTS
MERQ
MSFT
VRTS
EBAY
AMZN
VRSN
CHKP
Healthcare
BIIB
IVGN
AMGN
CEPH
CHIR
GILD
GENZ
TEVA
MEDI
PDCO
HSIC
ESRX
XRAY
BMET
LNCR
FHCC
Services
CSWC
FAST
PETM
SPLS
KMRT
WFMI
PIXR
LAMR
PAYX
FISV
IACI
DISH
CMCSA
SBUX
APOL
CTAS
Transportation
EXPD
CHRW
Basic
SSAL
SSCC
Consumer Cyclicals
PCAR
GNTX
Energy
Applet com.labescape.config.Applet started
Internet

Example 4: Fisheye Menus

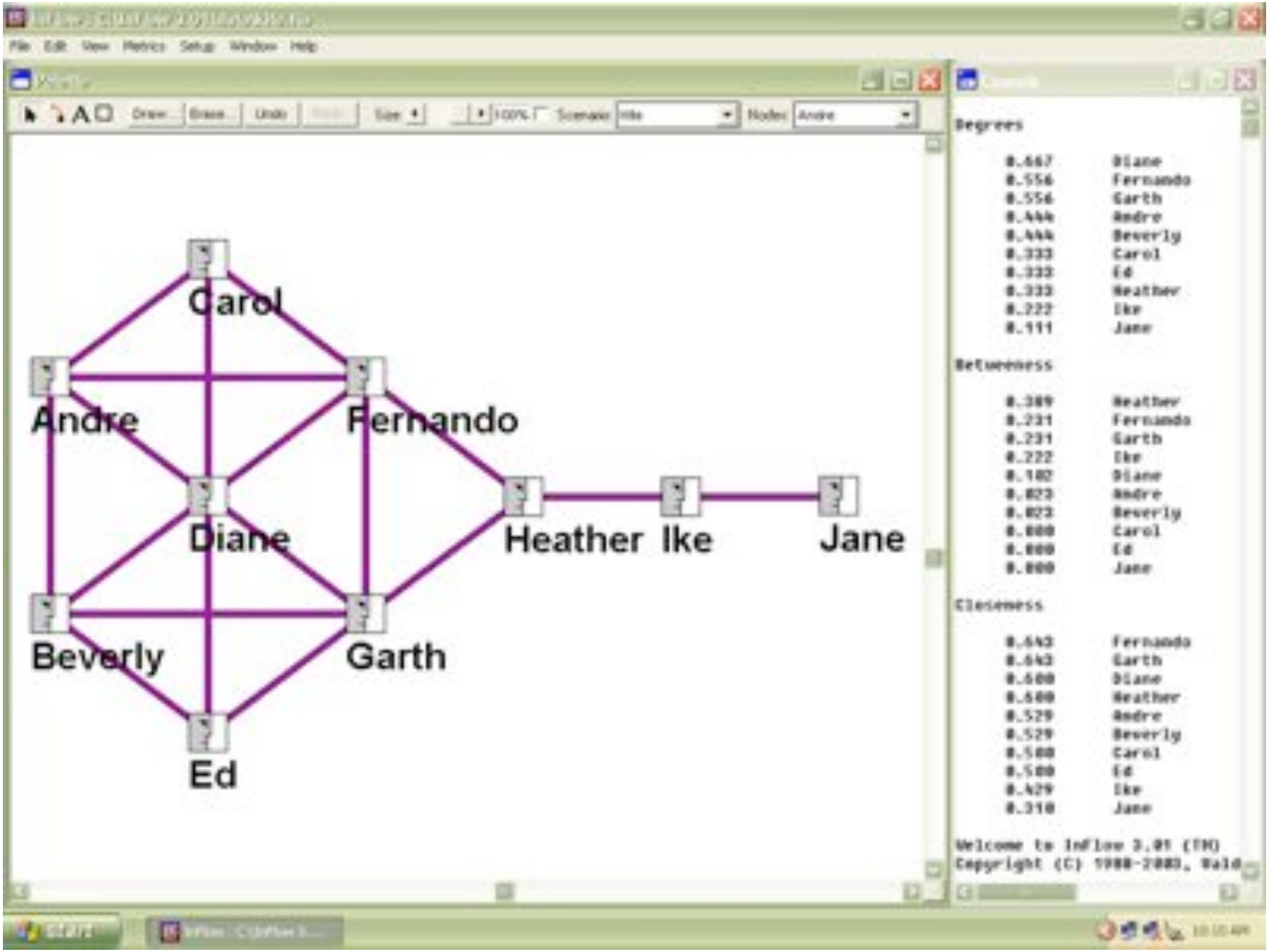


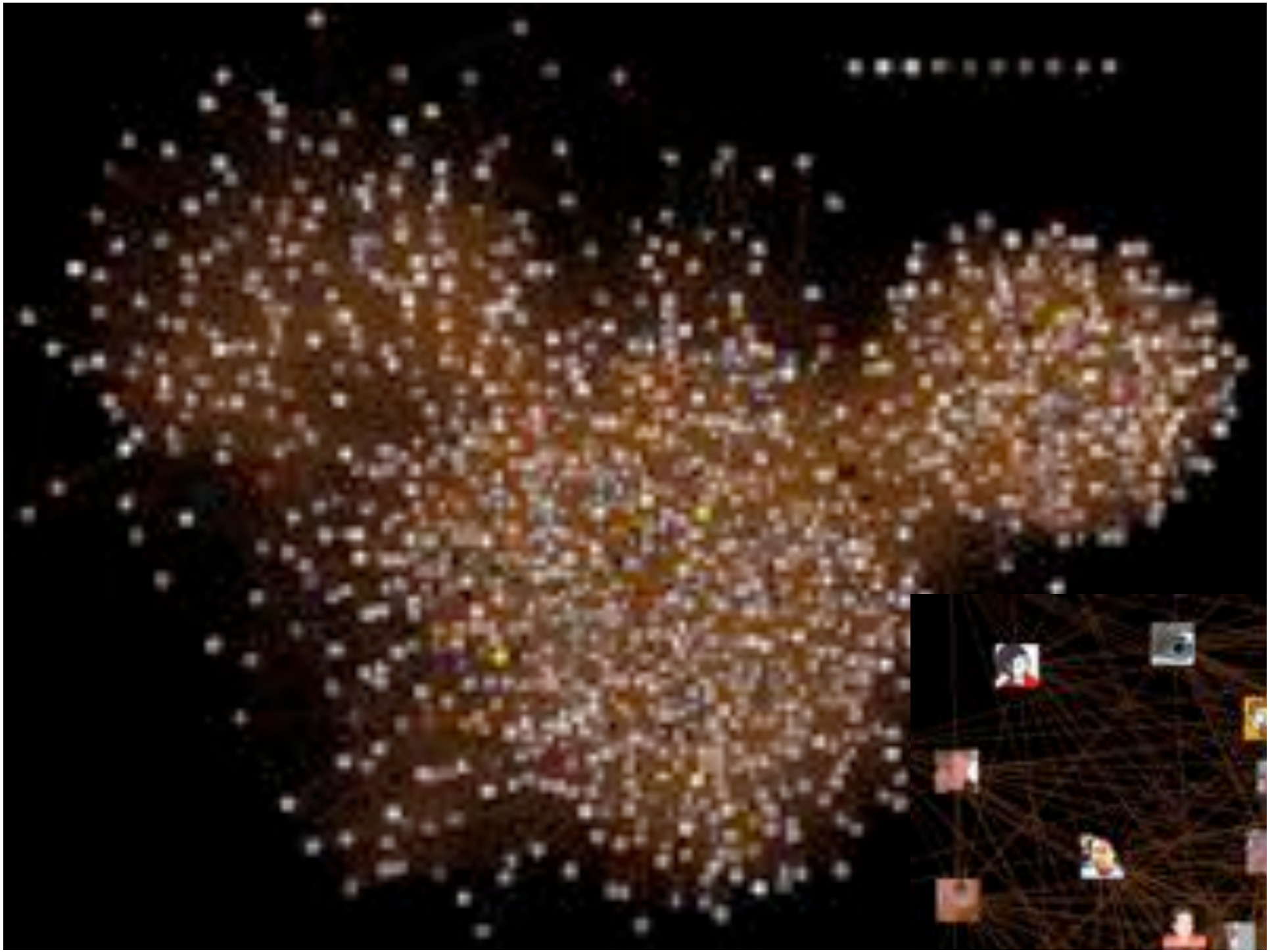
Example 5: Tag Clouds

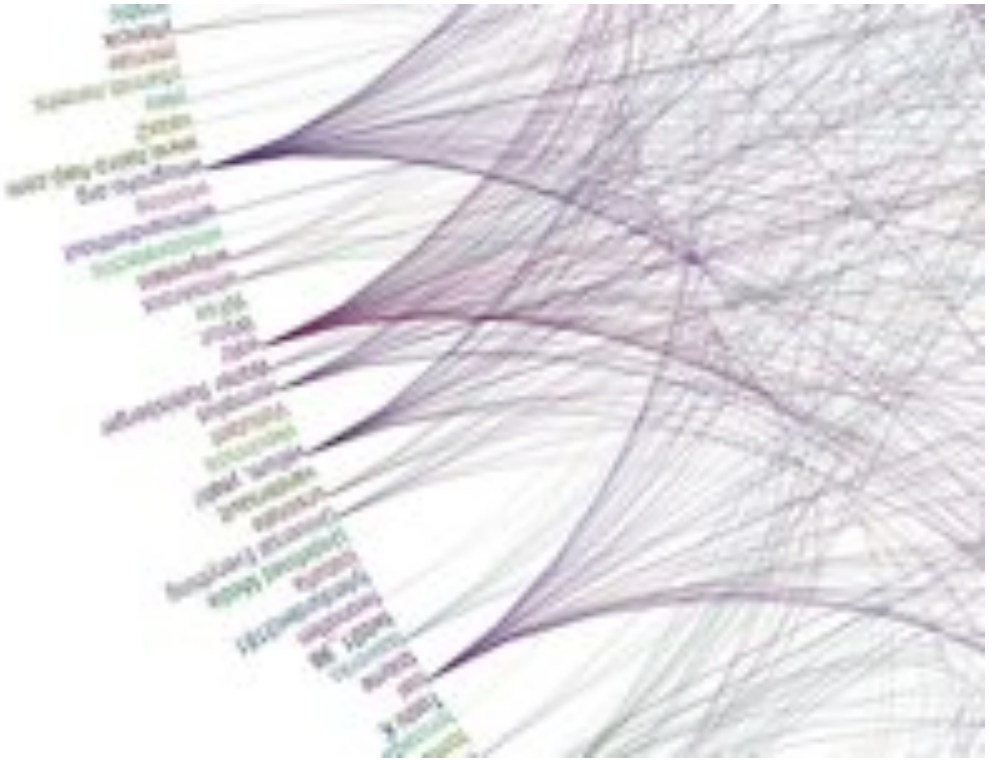


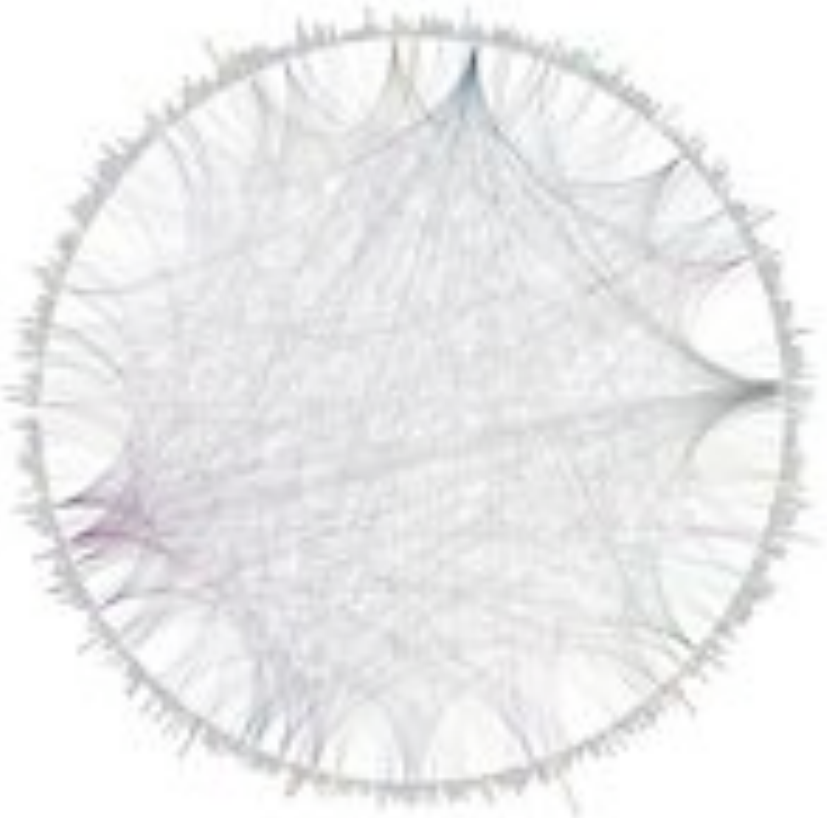
Visualising relationships

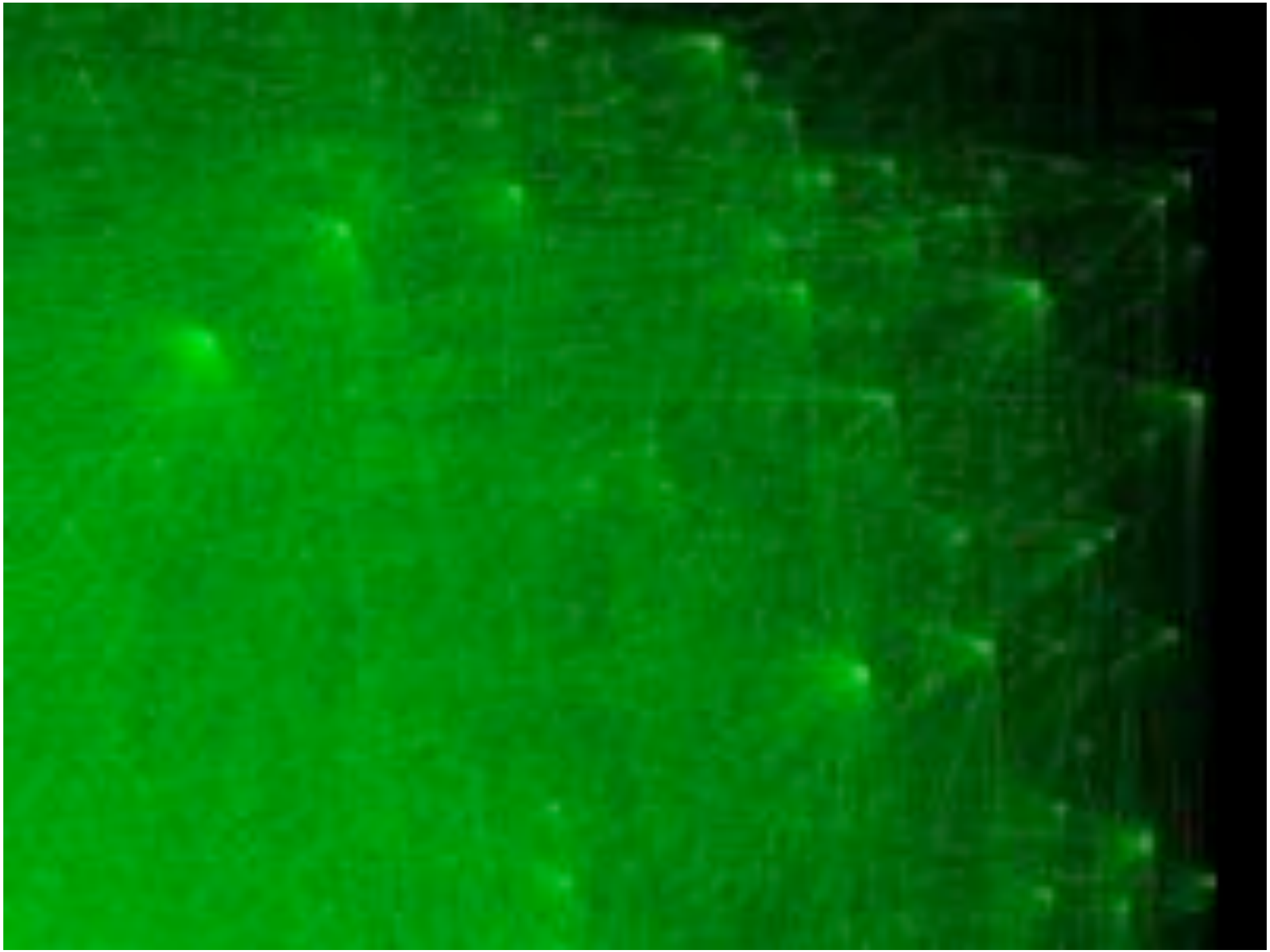
- Friendship networks
- Food chain networks
- Economic networks
- Terrorist networks


Carol
Andre
Fernando
Diane
Heather
Ike
Jane
Beverly
Garth
Ed
Degrees
0.667 Diane
0.556 Fernando
0.556 Garth
0.444 Andre
0.444 Beverly
0.333 Carol
0.333 Ed
0.333 Heather
0.222 Ike
0.111 Jane
Betweenness
0.389 Heather
0.231 Fernando
0.231 Garth
0.222 Ike
0.102 Diane
0.023 Andre
0.023 Beverly
0.000 Carol
0.000 Ed
0.000 Jane
Closeness
0.643 Fernando
0.643 Garth
0.600 Diane
0.600 Heather
0.529 Andre
0.529 Beverly
0.500 Carol
0.500 Ed
0.429 Ike
0.310 Jane
Welcome to InFlow 3.01 (TM)
Copyright (C) 1988-2003, Wald





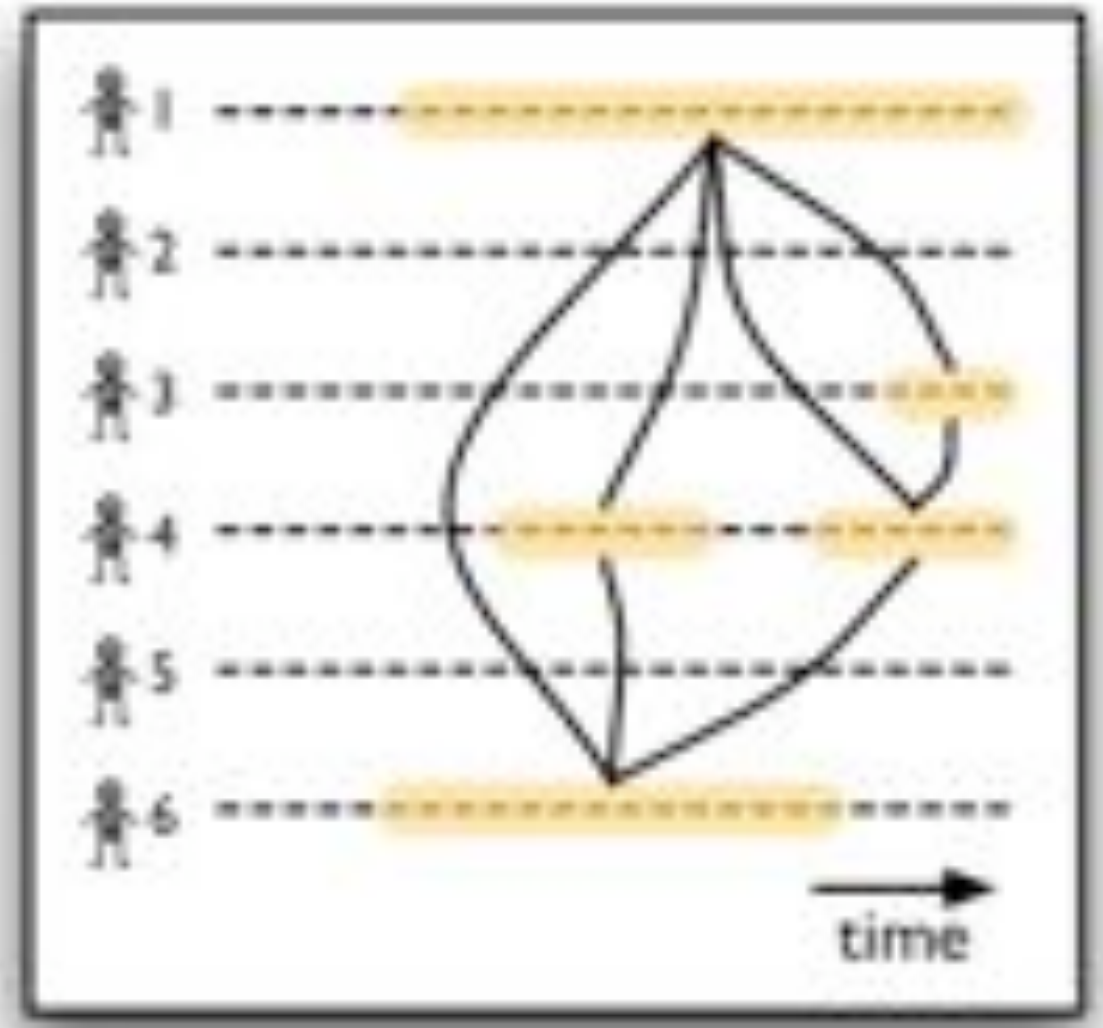


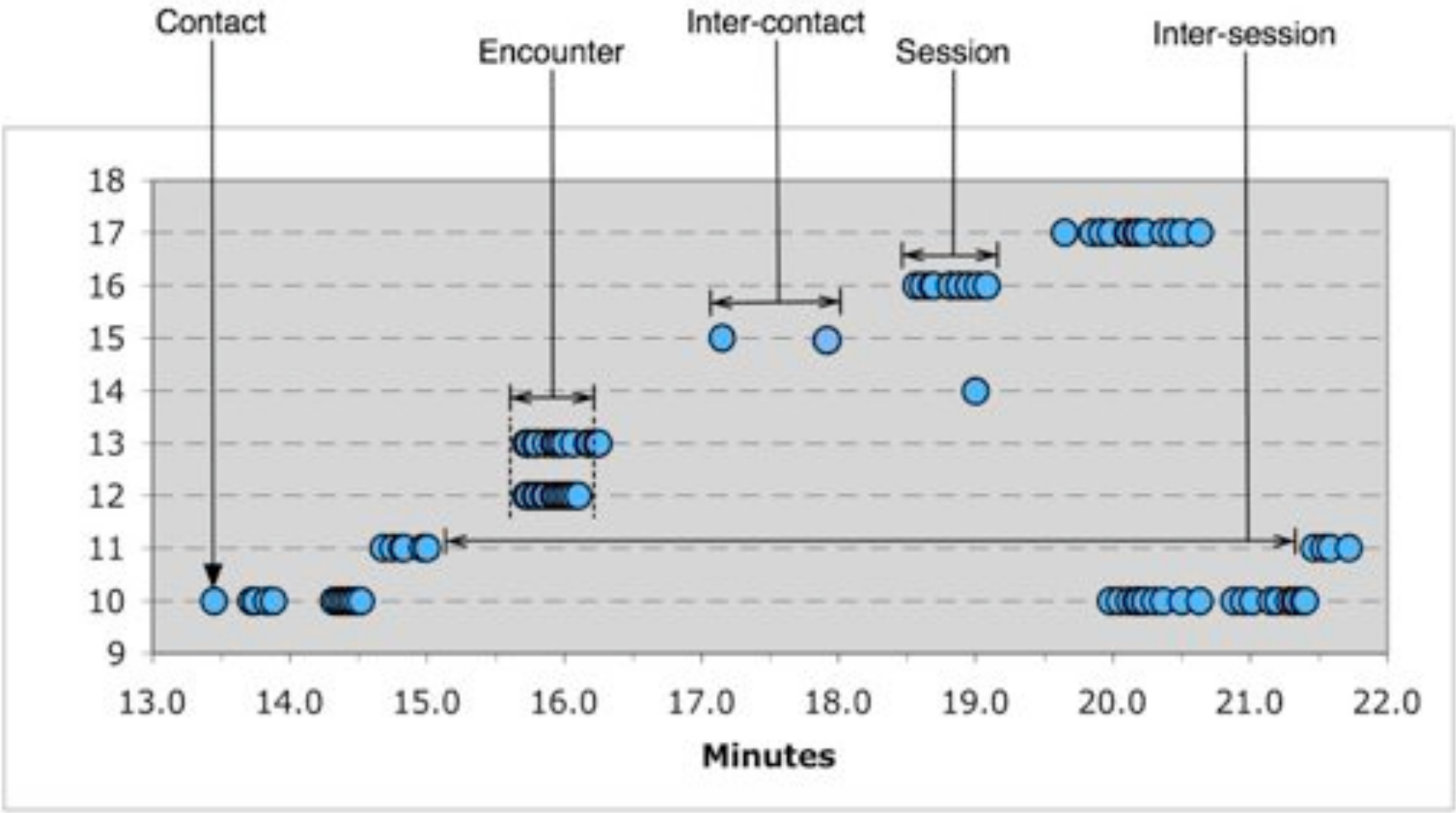


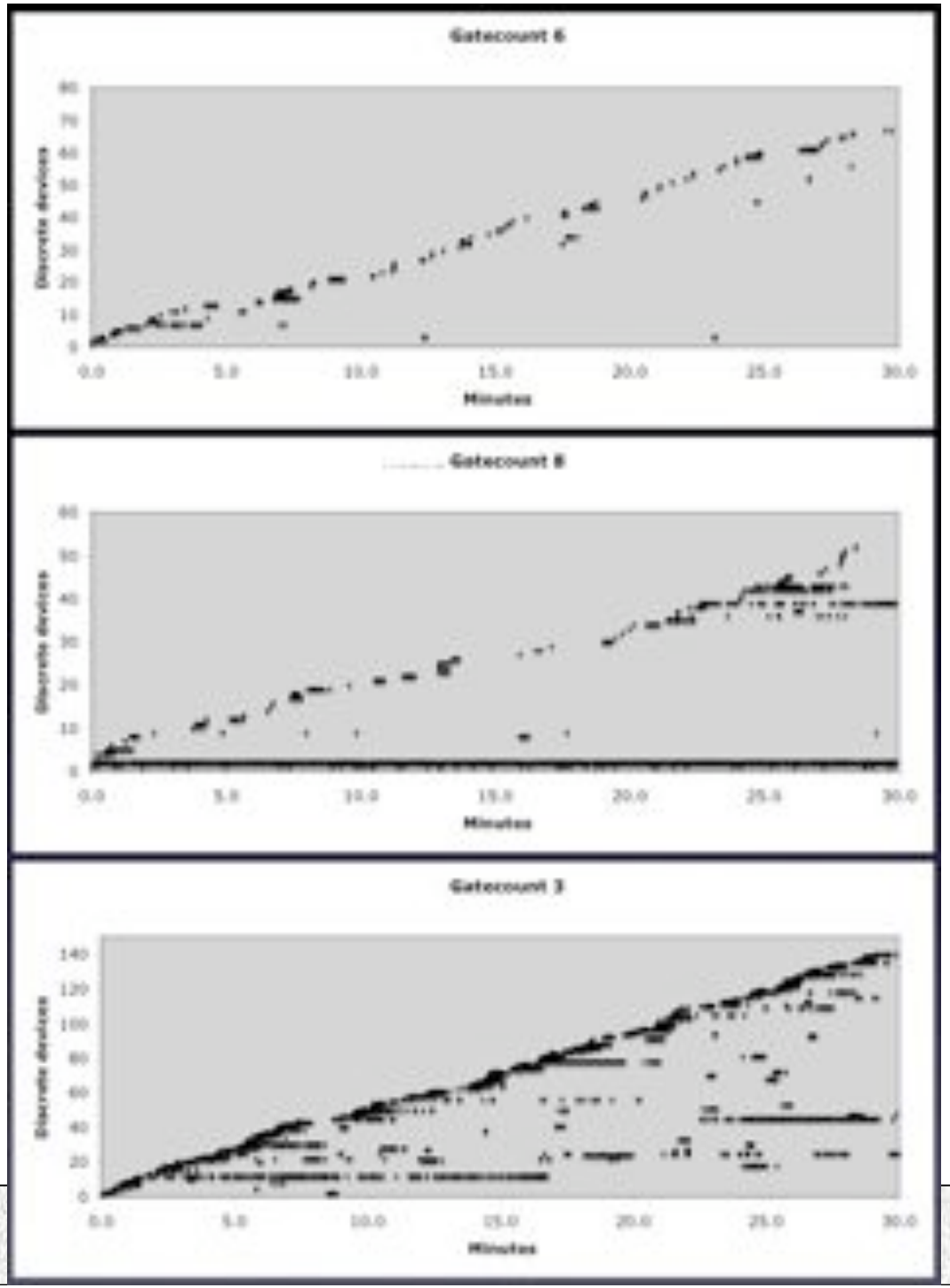
Project 3

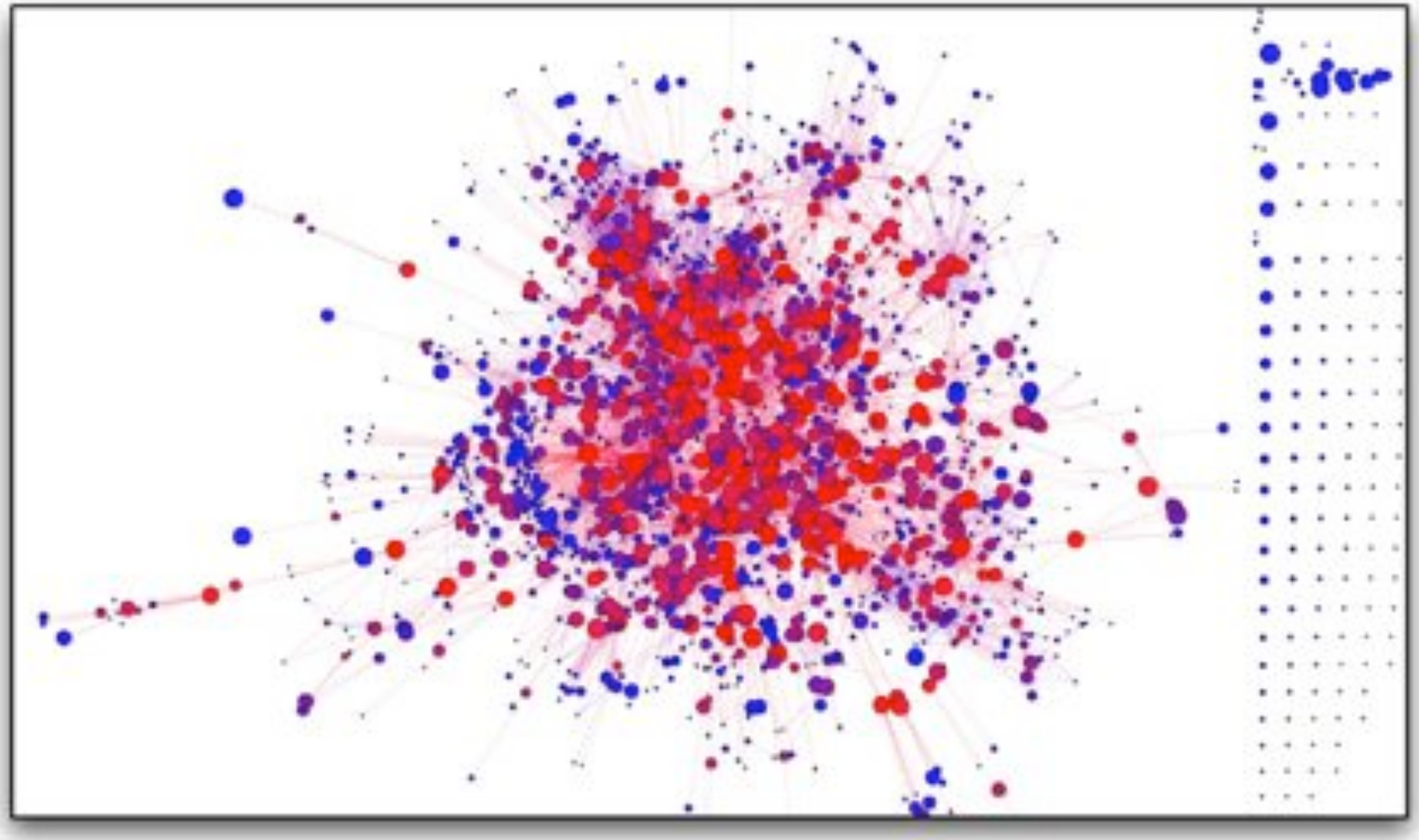
- Come up with novel visualisations of Bluetooth Encounters.

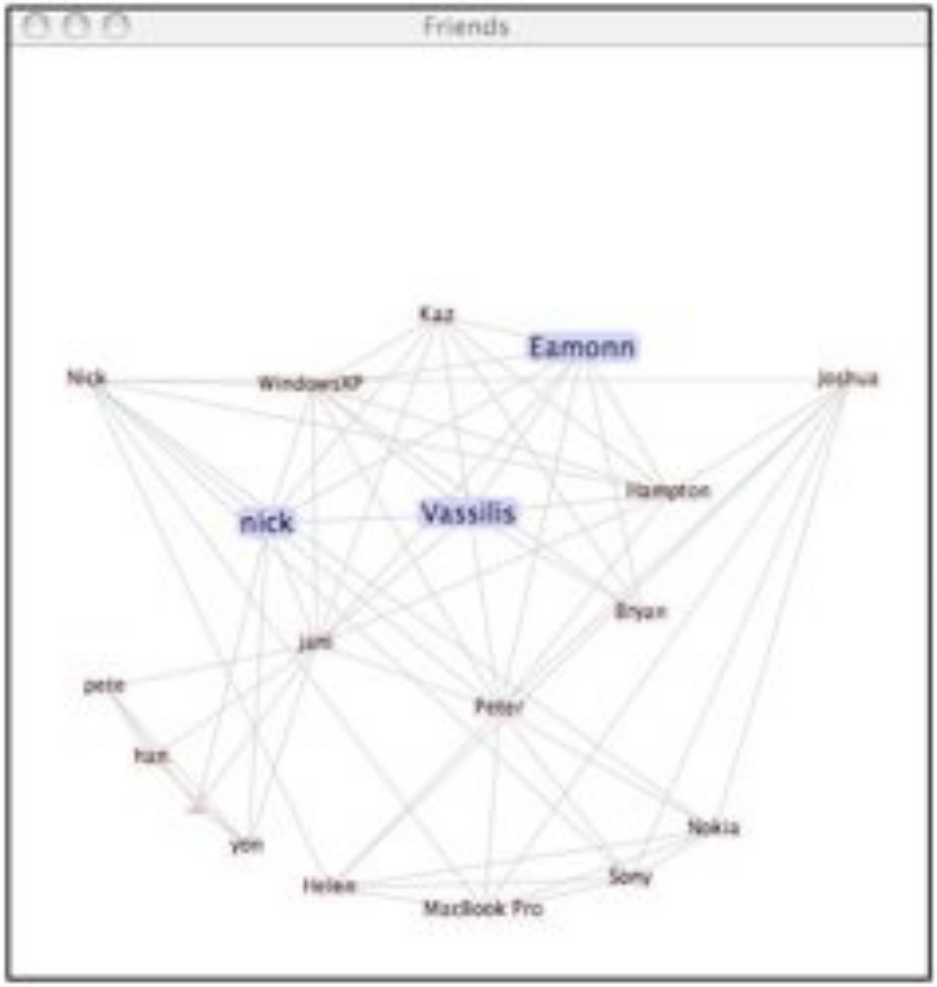

2
5
1
4
Scanner
3
6

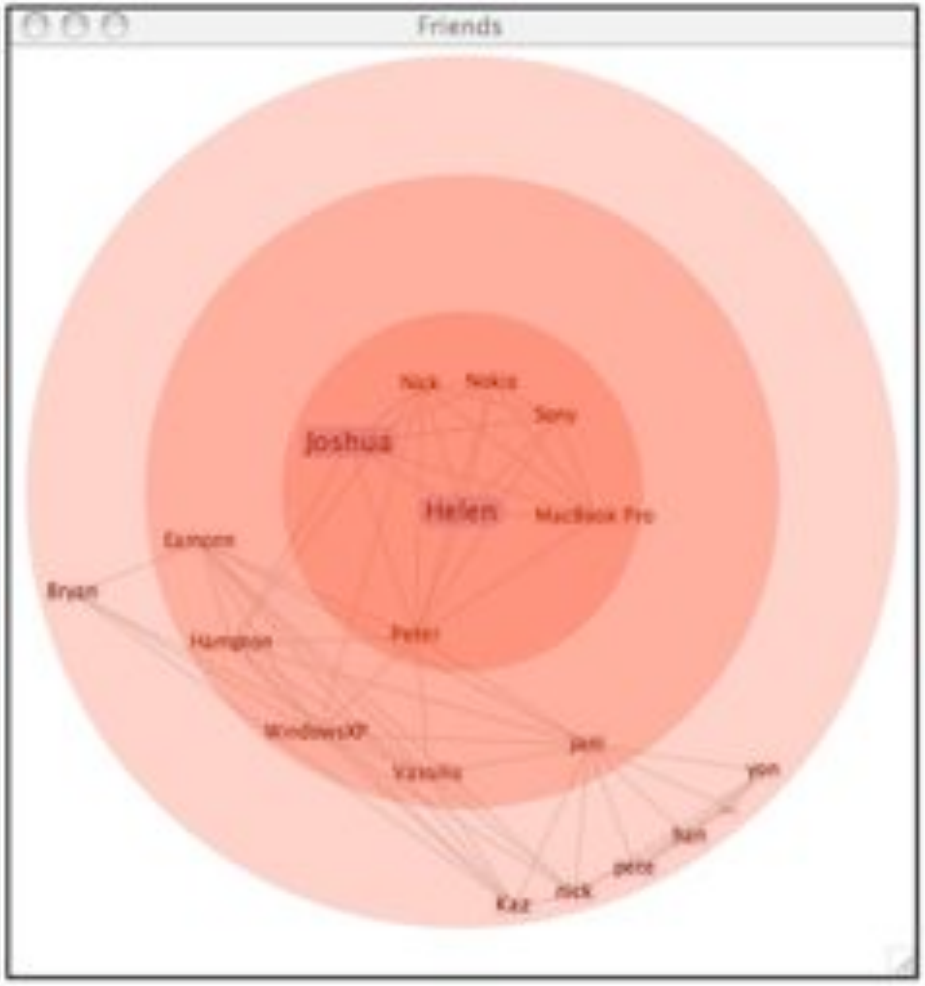

1
2
3
4
5
6
time

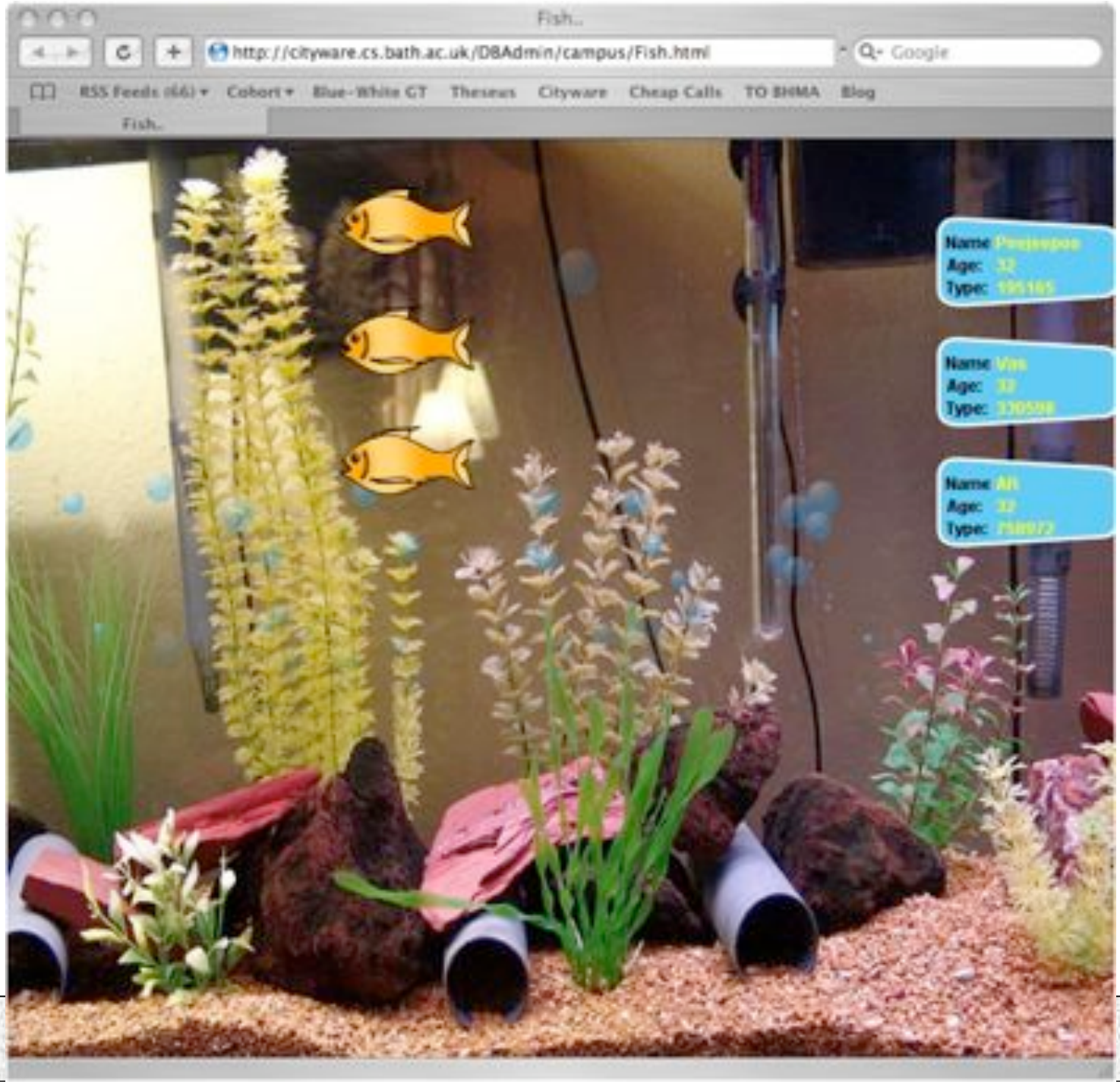

Contact
Encounter
Inter-contact
Session
Inter-session
18
17
16
15
14
13
12
11
10
9
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
Minutes


Gatecount 6
Discrete devices
Minutes
Gatecount 8
Discrete devices
Minutes
Gatecount 3
Discrete devices
Minutes




Friends
Kaz
Eamonn
Nick
WindowsXP
Joshua
Hampton
nick
Vassilis
Bryan
jani
pete
Peter
han
yon
Nokia
Helen
Sony
MacBook Pro


Friends
Nick
Nokia
Sony
Joshua
Helen
MacBook Pro
Eamonn
Bryan
Hampton
Peter
WindowsXP
jani
Vassilis
yon
han
pete
nick
Kaz


Fish..
http://cityware.cs.bath.ac.uk/D8Admin/campus/Fish.html
Google
RSS Feeds (66)
Cohort
Blue-White GT
Theseus
Cityware
Cheap Calls
TO BHMA
Blog
Fish..
Name
Age: 32
Type:
Name Vas
Age: 32
Type:
Name Ali
Age: 32
Type:

Recap of Key Principles

- Overview first, zoom and filter, details on demand
- Focus + context
- Brushing and linking
- Make every pixel count
- Meaning of
  - Colour
  - Size
  - Layout / proximity
  - Transparency

InfoViz Toolkits

- Tableau Software
- prefuse
  - http://prefuse.org/gallery/

Some Issues

- Few usability tests demonstrating infoviz techniques work well (and by how much)
- Rapidly growing area

- Interested in seeing more?
  - http://www.style.org/
  - http://prefuse.org/gallery/
  - http://www.bewitched.com/research.html
  - http://services.alphaworks.ibm.com/manyeyes/home
  - http://www.visualcomplexity.com/vc/

Summary

- Information visualization for quickly exploring and explaining large sets of data
  - Overview first, zoom and filter, details on demand
  - Focus + context
  - Brushing and linking
  - Make every pixel count

Admin

- P3 is out!
- Visualise Bluetooth encounters