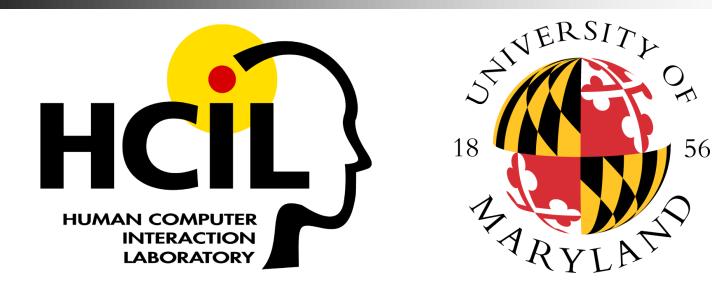
Information Visualization for Medical Informatics: Overview, Search & Summary for Electronic Health Records

Ben Shneiderman ben@cs.umd.edu
Catherine Plaisant plaisant@cs.umd.edu

Human-Computer Interaction Lab, Institute for Advanced Computer Studies







Interdisciplinary research community

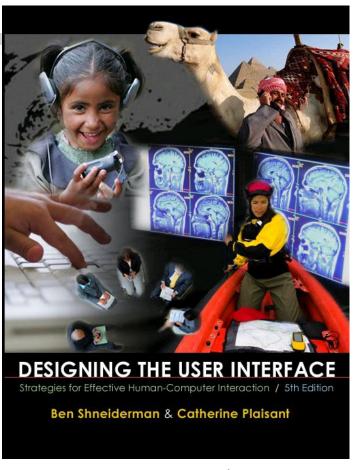
- Computer Science & Info Studies
- Psych, Socio, Poli Sci & MITH

(www.cs.umd.edu/hcil)



Design Issues

- Input devices & strategies
 - Keyboards, pointing devices, voice
 - Direct manipulation
 - Menus, forms, commands
- Output devices & formats
 - Screens, windows, color, sound
 - Text, tables, graphics
 - Instructions, messages, help
- Collaboration & Social Media
- Help, tutorials, training
- SearchVisualization



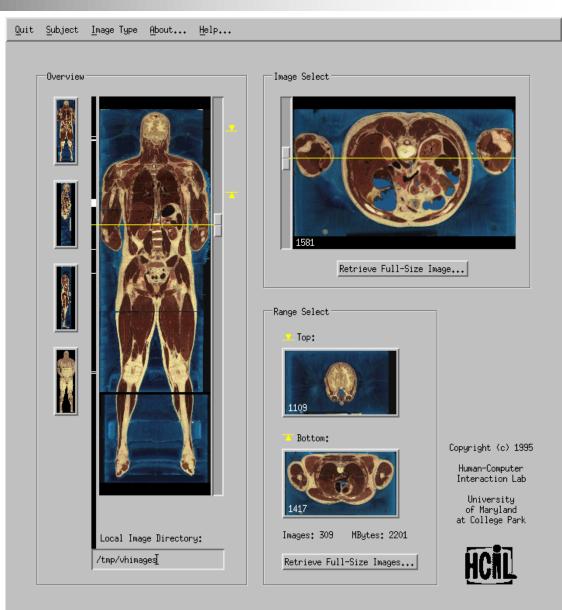
www.awl.com/DTUI

Fifth Edition: 2010



Visible Human Explorer (NLM)

- Doctors
- Surgeons
- Researchers
- Students



NSF Digital Government Initiative



Census, NCHS, BLS, EIA, NASS, SSA

- Find what you need
- Understand what you Find





www.ils.unc.edu/govstat/

FEDSTATS



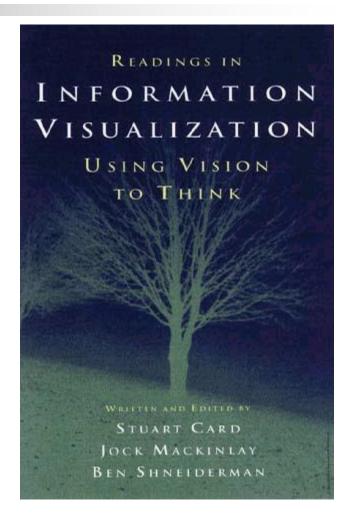
Information Visualization

Visual bandwidth is enormous

- Human perceptual skills are remarkable
 - Trend, cluster, gap, outlier...
 - Color, size, shape, proximity...
- Human image storage is fast and vast

Three challenges

- Meaningful visual displays of massive data
- Interaction: widgets & window coordination
- Process models for discovery:
 Integrate statistics & visualization
 Support annotation & collaboration
 Preserve history, undo & macros





Anscombe's Quartet

1		2		3		4	
X	У	X	у	X	у	X	У
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89



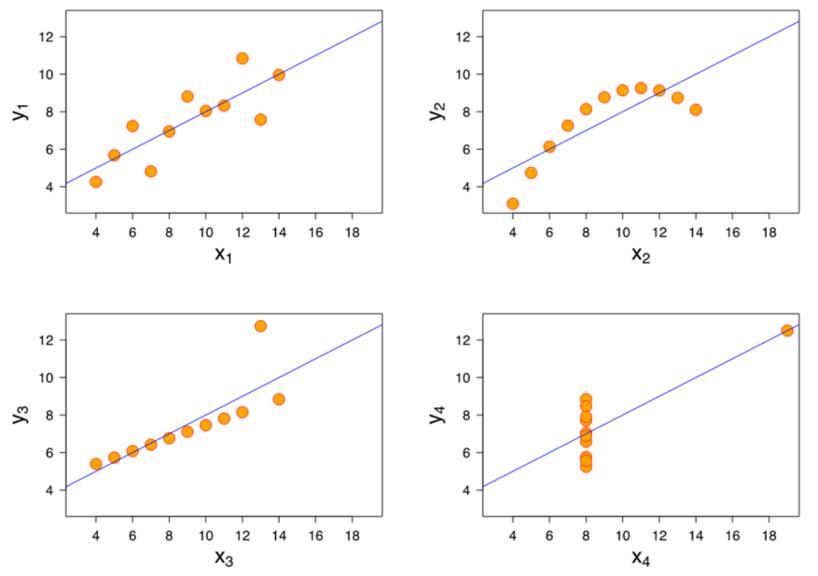
Anscombe's Quartet

1		2		3		4	
x	У	X	у	X	у	X	У
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Property	Value		
Mean of x	9.0		
Variance of x	11.0		
Mean of y	7.5		
Variance of y	4.12		
Correlation	0.816		
Linear regression	y = 3 + 0.5x		

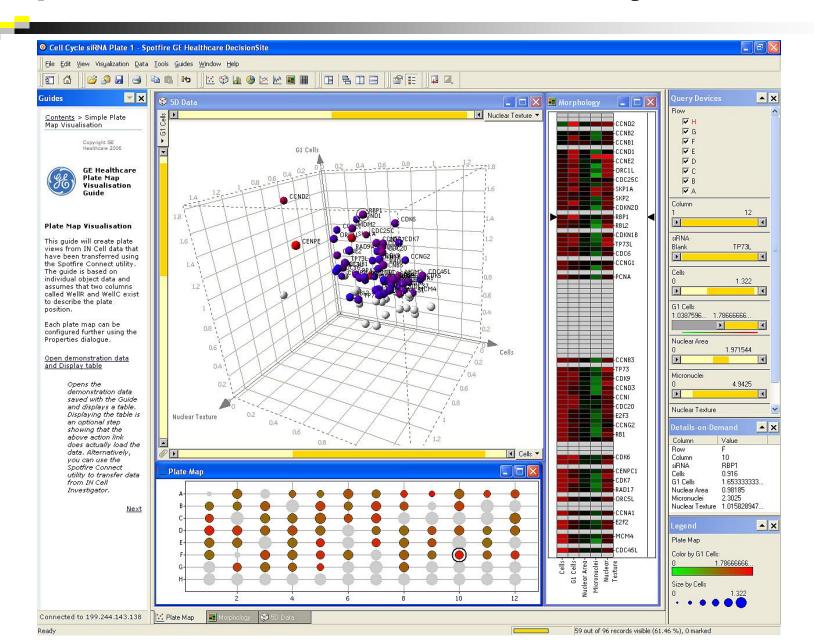


Anscombe's Quartet



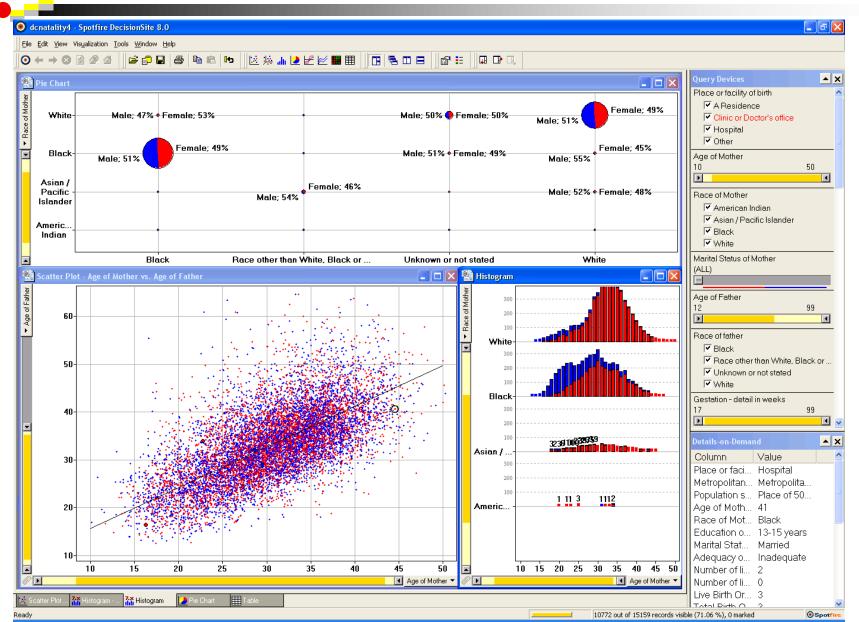


Spotfire: Retinol's role in embryos & vision





Spotfire: DC natality data



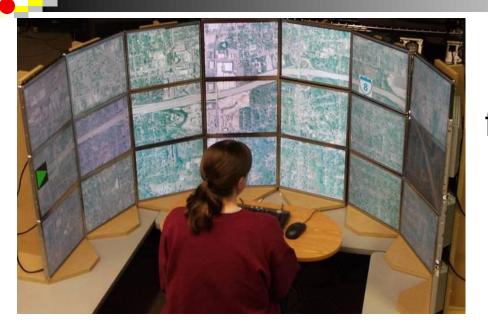








10M - 100M pixels



Large displays for single or multiple users





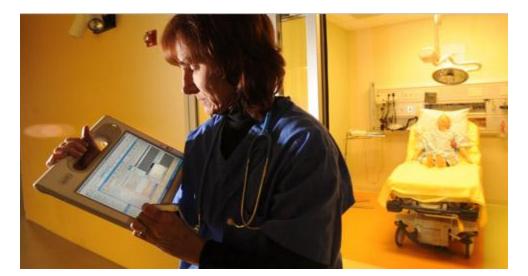


1M-pixels & less









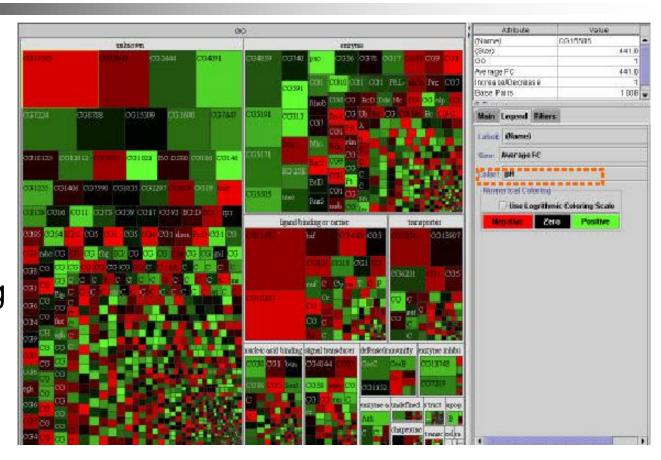
Small mobile devices





Treemap: Gene Ontology

- + Space filling
- + Space limited
- + Color coding
- + Size coding
- Requires learning

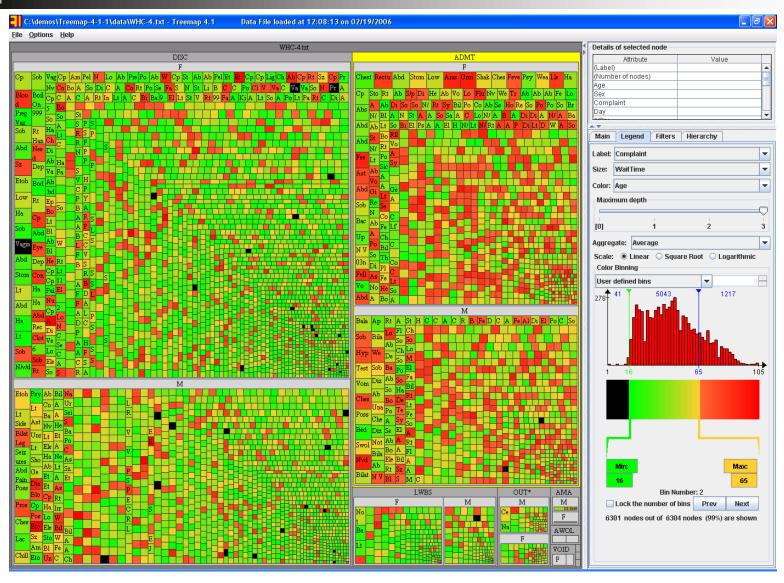


(Shneiderman, ACM Trans. on Graphics, 1992 & 2003)



Treemap: WHC Emergency Room

(6304 patients in Jan2006)

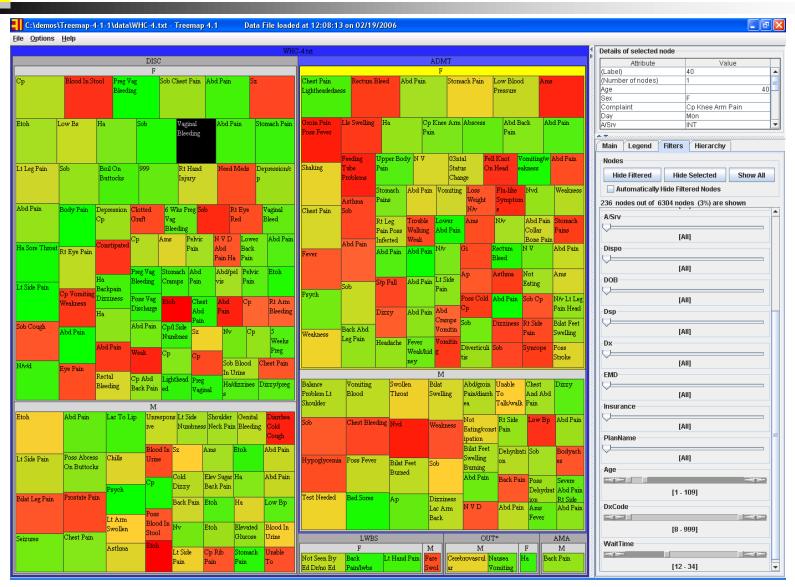




Group by Admissions/MF, size by service time, color by age

Treemap: WHC Emergency Room

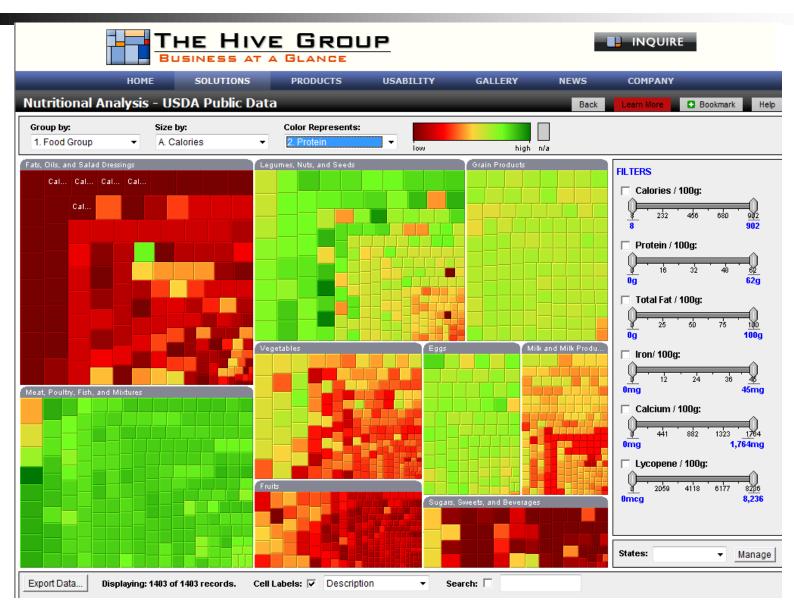
(6304 patients in Jan2006) (only those service time >12 hours)





Group by Admissions/MF, size by service time, color by age

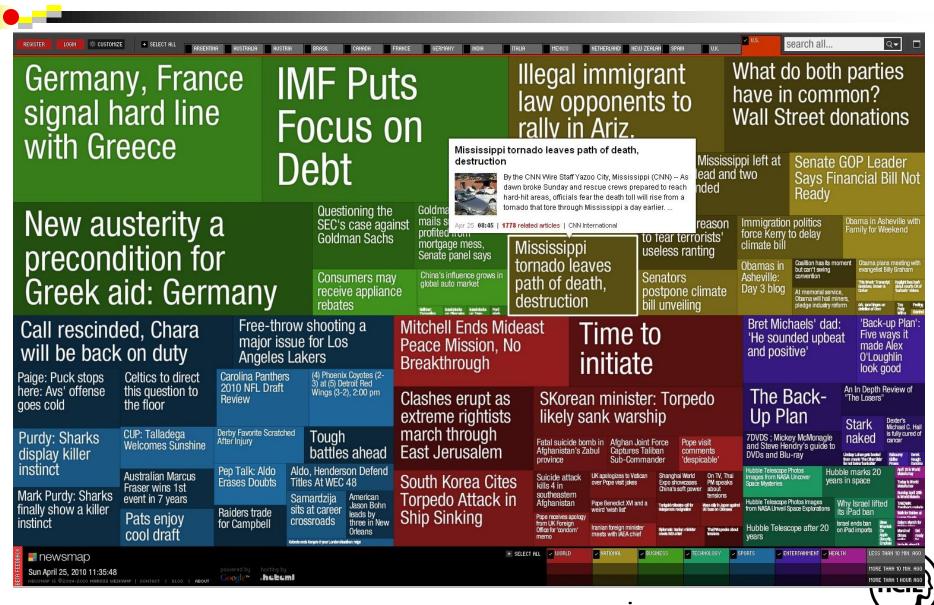
Treemap: Nutritional Analysis





www.hivegroup.com

Treemap: Newsmap (Marcos Weskamp)



Newsmap: Health News in US, UK & AU



CHOLERA in HAITI: a view from a first responder



Forget 'baby brain' mothers' grey matter grows after the birth

Teenagers' sleep a clue to mental health risk

CPR switch: No more mouth to mouth?

Regimen May Prevent Colorectal Cancer

36 under-18s hospitalised because of alcohol every day

Mosquito Evolution May Make It Harder to Fight Malaria: Study

Spending Around 61% of School-Age Girls Review: Care Receive **HPV** Vaccine cuts 'may hit hospital

MRI scans 'are too sensitive

💶 newsmap Sun October 24, 2010 8:35:13

beds'

NY Times: Visualization Lab

The New York Times

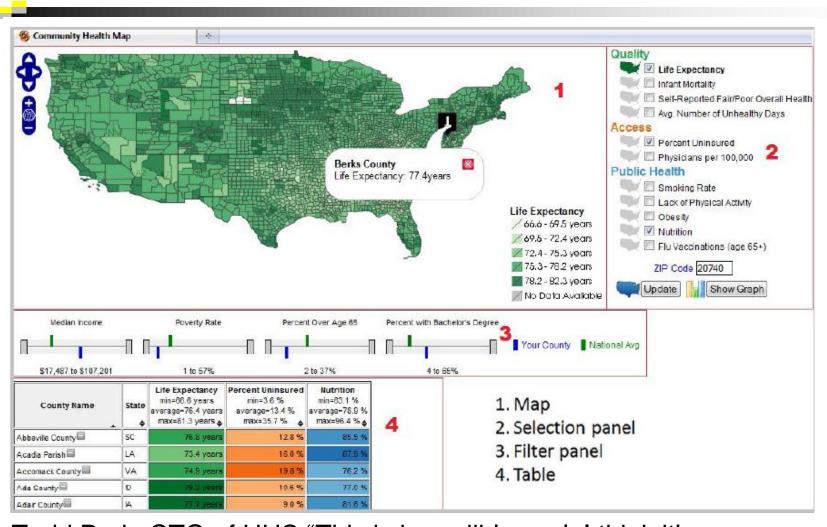
Sunday, October 24, 2010

Treemap for Comparisons of Number of infant deaths per 100,000 live births in selected countries

Browse All Visualizations » Created by an anonymous user Treemap Organization (Drag to Reorder) Country ROMANIA CHILE UNITED STATES NORTHERN IREL.. CANADA ENGLAND AN... IRELAND England and W., Northern Ireland Canada Ireland United States Romania SCOTLAND DENMARK BELGIUM SWITZERL. GERMANY HUNGARY PUERTO RICO Scotland Switzerland Denmark Belgium Germany Hungary Puerto Rico AUSTRALIA GREECE **PORTUGAL** FRANCE CZECH R... BULGARIA Australia Greece France Czech Re.. CUBA POLAND Bulgaria **AUSTRIA** ITALY Cuba Poland **SPAIN** NORWAY SWEDEN Austria : Italy: Norway Sweden COSTA RICA NEW ZEALAND SLOVAKIA JAPAN HONG... ISRAEL NETHERLAN... FINLAND Costa Rica Slovakia New Zealand Israel Netherlands Finland < -94 -74.8 + 2 Search>> First 1960 Second 2004 This data set has 1 positive and Data file: Number of infant deaths per 100,000 live births Data source: National Center for Health Statistics 1 negative ratings. in selected countries



Community Health Data Map

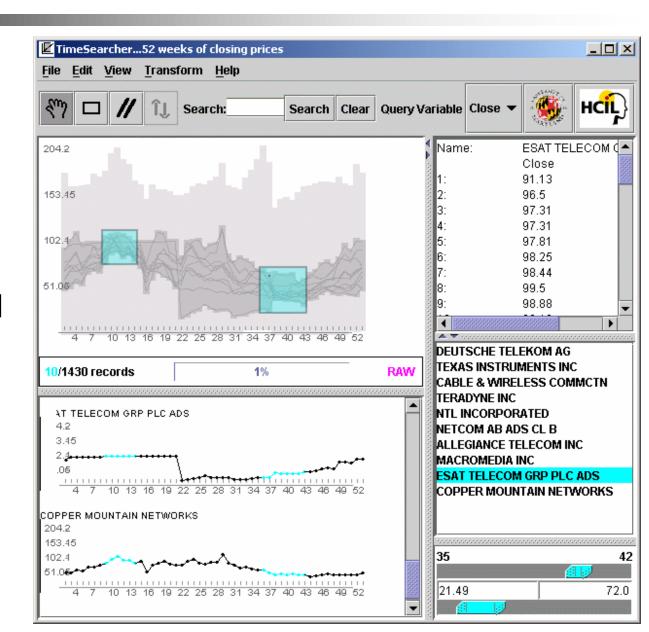


Todd Park, CTO of HHS: "This is incredibly cool, I think it's spare, elegant, and Intuitive...The White House and HHS see this as a powerful seed for changing health care in the United States."



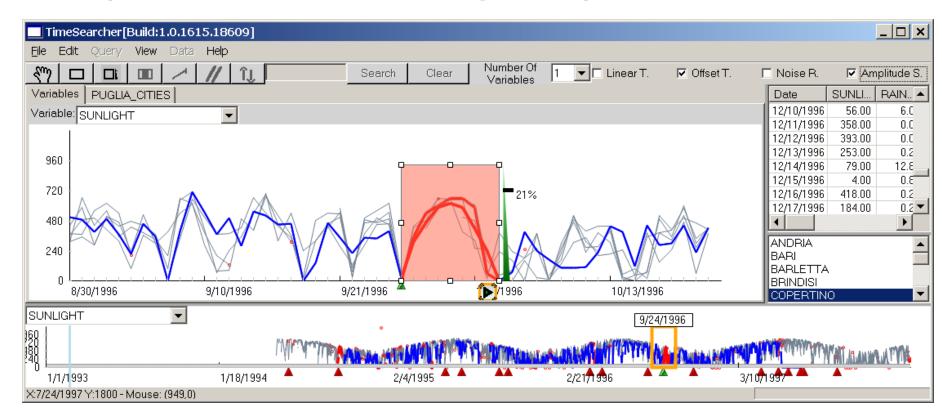
Temporal Data: TimeSearcher 1.3

- Time series
 - Stocks
 - Weather
 - Genes
- User-specified patterns
- Rapid search

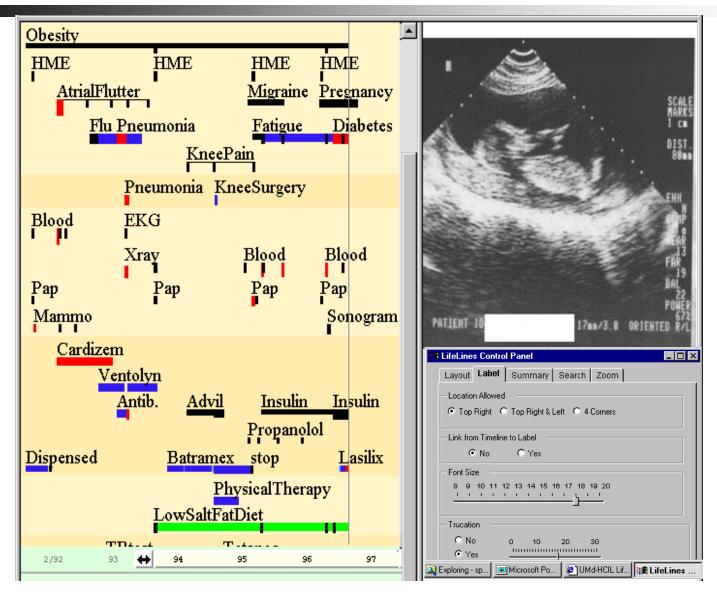


Temporal Data: TimeSearcher 2.0

- Long Time series (>10,000 time points)
- Multiple variables
- Controlled precision in match (Linear, offset, noise, amplitude)



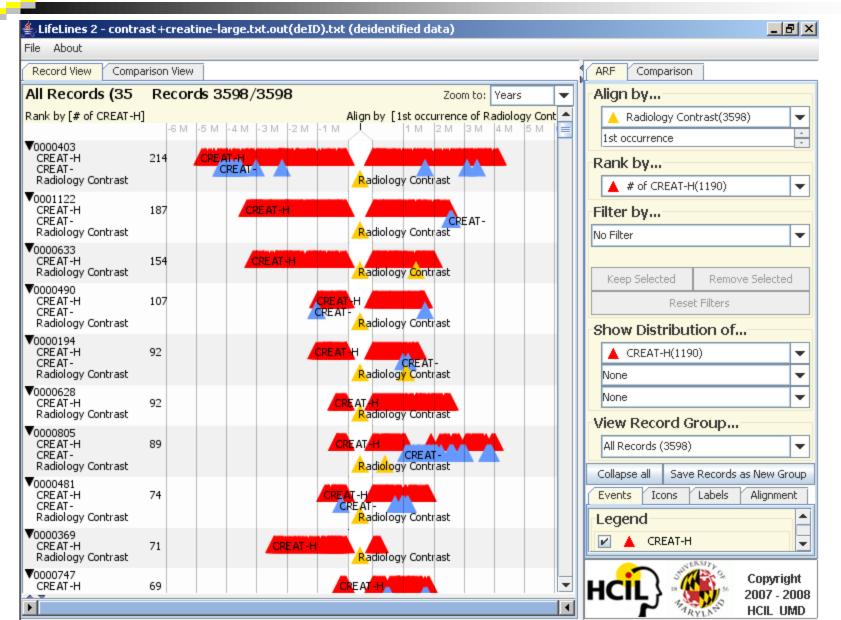
LifeLines: Patient Histories





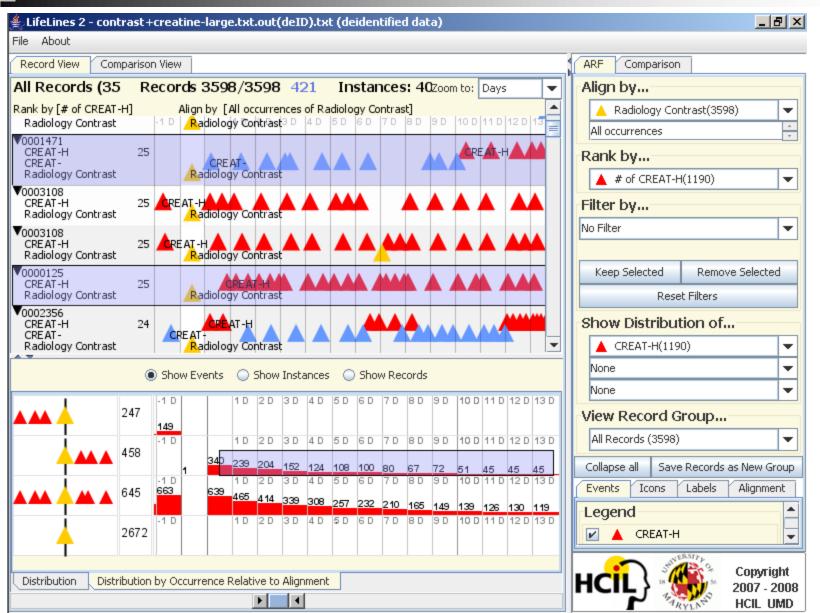
www.cs.umd.edu/hcil/lifelines

LifeLines2: Contrast+Creatine





LifeLines2: Align-Rank-Filter & Summarize



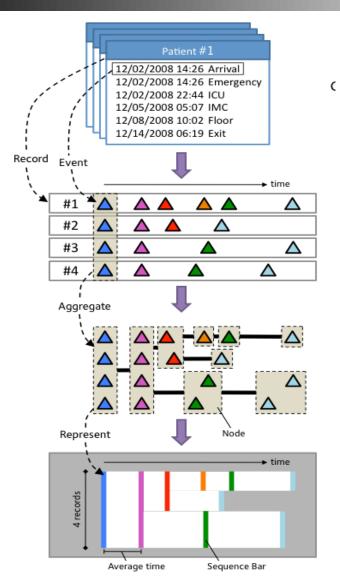


LifeLines2: Align-Rank-Filter & Summarize





LifeFlow: Aggregation Strategy



Temporal
Categorical Data
(4 records)

LifeLines2 format

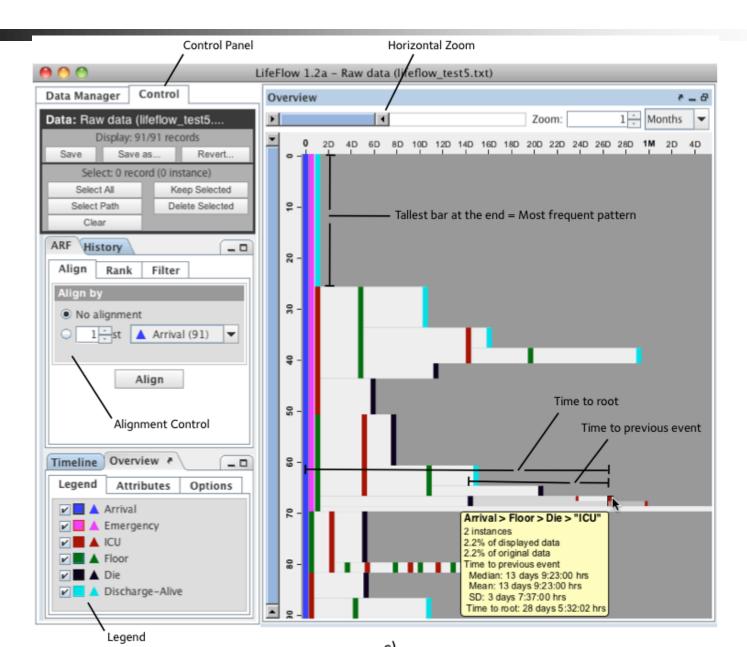
Tree of Event Sequences

LifeFlow Aggregation



www.cs.umd.edu/hcil/lifeflow

LifeFlow: Interface with User Controls





Process Model: Temporal Event Analysis

- Data acquisition, wrangling & cleaning
- Examine data in visualization
- Exploratory Search
 - Systematically, yet flexibly apply visual operators
 - Deal with unexpected findings
- Analysis & Explanation
 - Determine to what extent the questions are answered
 - System & data limitations
 - Refine existing questions
- Report to colleagues
 - Document discoveries & disseminate results



Office of National Coordinator: SHARP

National Research Council report (2008)

Computational Technology for Effective Health Care: Immediate Steps and Strategic Directions

www.nap.edu/catalog/12572.html

Strategic Health IT Advanced Research Projects

- Security of Health Information Technology
- Patient-Centered Cognitive Support
- Healthcare Application and Network Platform Architectures
- Secondary Use of EHR Data



National Center for Cognitive Informatics & Decision Making in Healthcare

Work-Centered Design of Care Process Improvements in HIT

Cognitive Foundations for Decision Making: Implications for Decision Support

Modeling of Setting-Specific Factors to Enhance Clinical Decision Support Adaptation

Automated Model-Based Clinical Summarization of Key Patient Data

Cognitive Information Design and Visualization: Enhancing Accessibility and Understanding of Patient Data:

Construct an interface which supports the integration of clinical understanding, decision making, and problem solving. This project will also provide metrics to evaluate and compare the efficacy of this open-source interface as compared to commercial interfaces



UMD HCIL Early Directions

Missing Laboratory Reports

Medication Reconciliation

Alarms and Alerts Management





28th Annual Symposium May 26-27, 2011

www.cs.umd.edu/hcil



For More Information

- Visit the HCIL website for 400 papers & info on videos
 www.cs.umd.edu/hcil
- Conferences & resources: www.infovis.org
- See Chapter 14 on Info Visualization
 Shneiderman, B. and Plaisant, C., Designing the User Interface:
 Strategies for Effective Human-Computer Interaction:
 Fifth Edition (March 2009)
 www.awl.com/DTUI
- Edited Collections:
 - Card, S., Mackinlay, J., and Shneiderman, B. (1999)

 Readings in Information Visualization: Using Vision to Think

 Bederson, B. and Shneiderman, B. (2003)

 The Craft of Information Visualization: Readings and Reflections



For More Information

- Treemaps
 - **HiveGroup:** www.hivegroup.com
 - Smartmoney: www.smartmoney.com/marketmap
 - HCIL Treemap 4.0: www.cs.umd.edu/hcil/treemap
- Spotfire: www.spotfire.com
- TimeSearcher: www.cs.umd.edu/hcil/timesearcher
- NodeXL: nodexl.codeplex.com
- Hierarchical Clustering Explorer:

www.cs.umd.edu/hcil/hce

- LifeLines2: www.cs.umd.edu/hcil/lifelines2
- Similan: www.cs.umd.edu/hcil/similan

