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

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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
- Search
- Visualization

www.awl.com/DTUI
Fifth Edition: 2010
Visible Human Explorer (NLM)

- Doctors
- Surgeons
- Researchers
- Students
NSF Digital Government Initiative

- Find what you need
- Understand what you Find

Census, NCHS, BLS, EIA, NASS, SSA

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

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<td>Correlation</td>
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<td>Linear regression</td>
<td>$y = 3 + 0.5x$</td>
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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


www.cs.umd.edu/hcil/treemap/
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
Treemap: Newsmap (Marcos Weskamp)
Treemap for Comparisons of Number of infant deaths per 100,000 live births in selected countries

Created by an anonymous user

NY Times: Visualization Lab

Data file: Number of infant deaths per 100,000 live births in selected countries
Data source: National Center for Health Statistics

This data set has 1 positive and 1 negative ratings.
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
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

- **Control Panel**
- **Horizontal Zoom**
- **Alignment Control**
- **Legend**

**Tallest bar at the end = Most frequent pattern**

- **Time to root**
- **Time to previous event**

**Legend:**
- Arrival
- Emergency
- ICU
- Floor
- Die
- Discharge-Alive
Arrival > ER > "Exit-DISC"

4591 instances
65.2% of displayed data
65.2% of original data
Time to previous event
Median: 5:41:00 hrs
Mean: 8:07:05 hrs
SD: 1 days 19:08:01 hrs
Time to root: 9:30:42 hrs
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


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

[www.nap.edu/catalog/12572.html](http://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
- Edited Collections:
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