Finding Patterns of Events in Electronic Health Records Databases

Stanley Lam, Catherine Plaisant, Ben Shneiderman

with Patti Abbott (JHU), Nathaniel Ayewah, Alex Quinn, Roman Stanchak, David Wang

Human-Computer Interaction Lab & Dept of Computer Science
Temporal Data is Pervasive!

- Health records
- Stock market trades
- Web log analysis
- Crime/terror activities
- Maintenance records
Temporal Data: TimeSearcher 2.0

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

www.cs.umd.edu/hcil/timesearcher
LifeLines: Visualizing Personal Histories

(Plaisant et al., CHI 1997)
KNAVE: Clinical Patient Data

Distributed Knowledge-Based Abstraction, Visualization, and Exploration of Time-Oriented Clinical Data

(Shahar, 1998)
Finding Patterns in Temporal Events

- Types of Time Data
  - Numerical Values (e.g., TimeSearcher)
  - Categorical Events & Intervals (e.g., LifeLines)
  - Categorical Events

- Goal: Find Temporal Patterns across Millions of Records
  - SQL makes it difficult to specify
Comparison with SQL

SELECT P.*
FROM Person P, Event E1, Event E2, Event E3, Event E4

WHERE P.PID = E1.PID
    AND P.PID = E2.PID
    AND P.PID = E3.PID
    AND P.PID = E4.PID
    AND E1.type = "Medication"
    AND E1.class = "Anti Depressant"
    AND E1.name = "Remeron"
    AND E2.type = "Medication"
    AND E2.class = "Anti Depressant"
    AND E2.name = "Remeron"
    AND E3.type = "Medication"
    AND E3.class = "Anti Depressant"
    AND E3.name = "Remeron"
    AND E2.value > E1.value
    AND E3.value >= E2.value
    AND E2.date > E1.date
    AND E3.date >= E2.date
    AND E4.type = "Visit"
    AND E4.class = "Hospital"
    AND E4.name = "Emergency"
    AND E4.value = "Heart Attack"
    AND E4.date >= E3.date
    AND 180 <= (E4.date – E3.date)

Patients with increasing dosages of Remeron followed by a heart attack within 180 days
Patients with increasing dosages of Remeron followed by a heart attack within 180 days.
Result set visualization: ball & chain

Five matches!

Patients with increasing dosages of Remeron followed by a heart attack within 180 days

www.cs.umd.edu/hcil/patternfinder
**Current work**

Washington Hospital Center & Partners HealthCare
- Developing taxonomy of simple queries based on interviews with physicians
- Designing interface to fit in Azyxxi
- Implementing simple searches:
  - Lab value [HGB] increases by 50% in 10 days
  - Lab value [Platelets] is high in a patient on heparin, then decreases > 20%
  - Patient seen at ER & discharged, then returns to ER within 14 days
  - Patient seen at ER & discharged, then returns to ER within 14 days & condition = [dead]
Patient History Search: WHC- PatternFinder

www.cs.umd.edu/hcil/patternfinder
Search Engine Optimization

Multiple self-joins are poorly handled in SQL Server
Very slow execution times

→ Add hand-written code in .NET to produce dramatic speed up in execution
Sentinel Events: LifeTimes

[Image of a graphical interface for LifeTimes, showing a grid with names and data points indicating sprained ACL and torn ACL events over time.]
Diverse Applications

Stock Market Trading
Buy, sell, put, call

Web log analysis
Browse books, checkout, help, leave website

Crime/terror activities
Withdraw funds, buy weapon, purchase tickets…

Maintenance records
Replace battery, repair generator, repair starter,…
Take Away Messages

Queries for temporal events are possible!
• Visual specification
• Rapid execution
• Visualization of results: ball & chain view

• Goal:
  Facilitate medical treatment & research

Thanks to:
  Washington Hospital Center & Partners HealthCare