

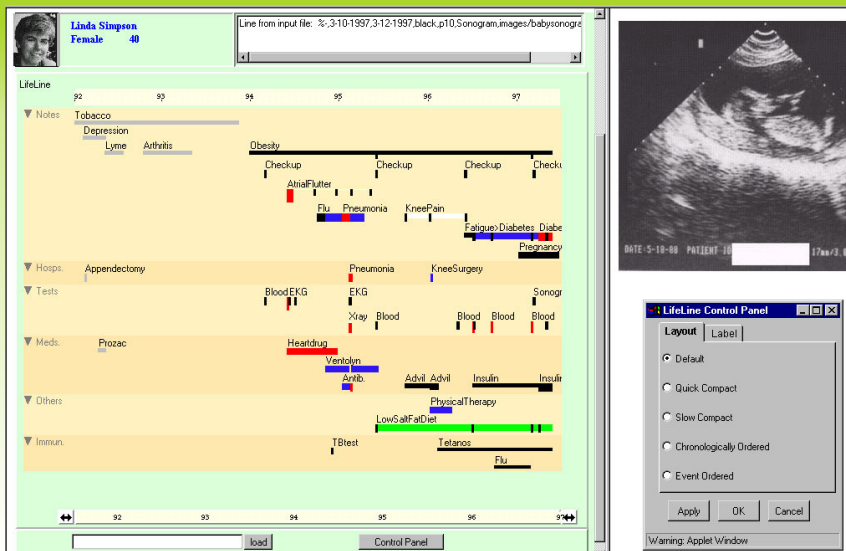
# Lifelines2: Hypothesis Generation in Multiple EHRs

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Catherine Plaisant  
Ben Shneiderman  
Shawn Murphy  
Mark Smith



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## LifeLines: Overview of Patient Record

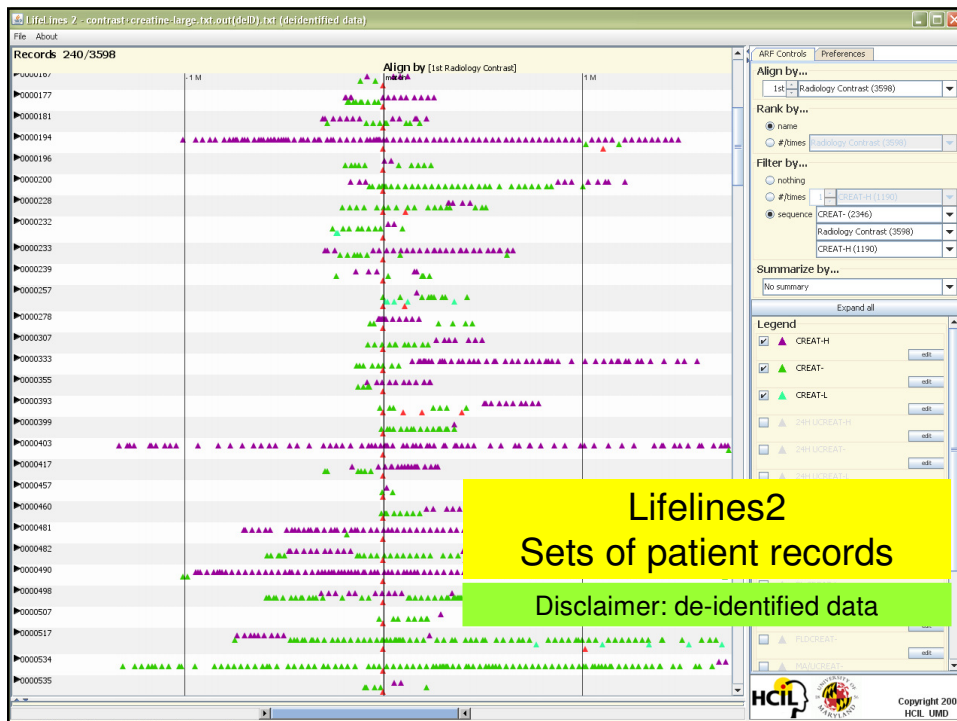


Plaisant et al., CHI96 AMIA98 - [www.cs.umd.edu/hcil/lifelines](http://www.cs.umd.edu/hcil/lifelines)

## Single record → Millions of records

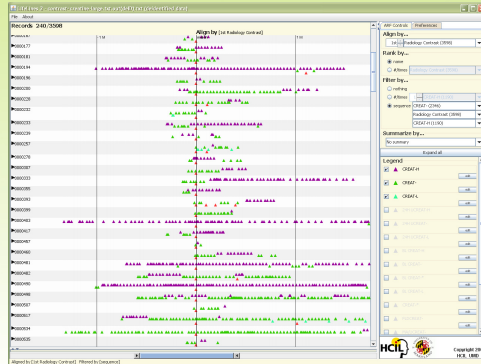
- Large databases of Electronic Health Records (EHRs):
  - Observational studies
  - Recruitment for clinical trials
  - Hospital metrics
  - Alarm design and testing
  - etc.

Often involves temporal comparison relative to an important event  
(e.g. heart attack, start of a treatment, 1<sup>st</sup> diagnosis of cancer)



## Lifelines2

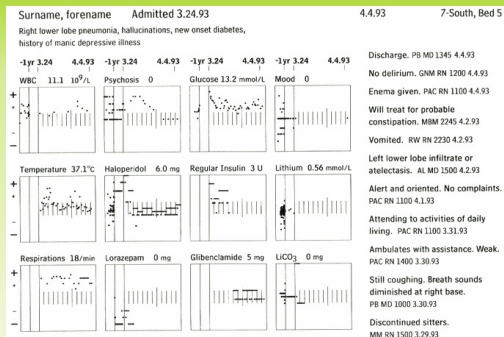
- Introduce powerful combination of simple operators **Align, Rank, Filter, and Summarize**
  - Multiple records simultaneously visible
  - Align by sentinel events
  - Rank by frequency
  - Filter by events
  - Summaries
- Focus on **Point Events**
  - Diagnosis, lab tests, etc.
- Measure **Benefits of Alignment**



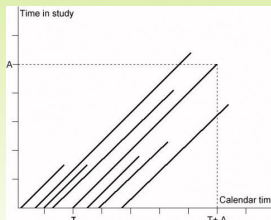
- **Sample of Related Work**
- Demo
- (Quick) Report on Studies
- Ongoing & Future Work



# Static views



Powsner & Tufte, 1994



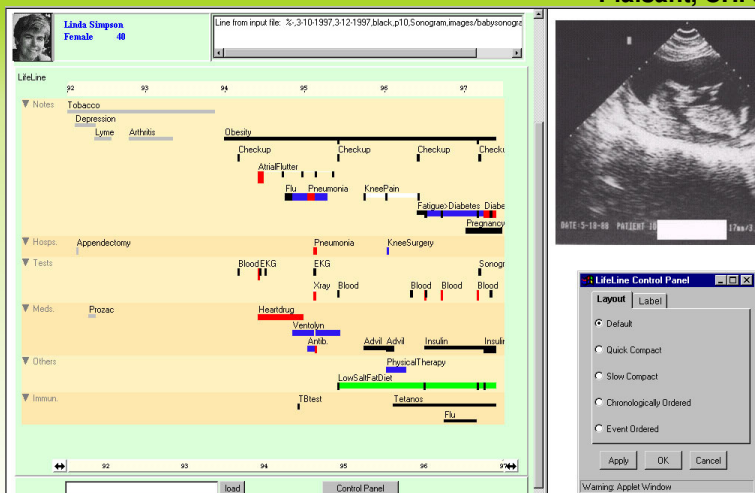
Lexis diagrams (Bertin)



# Lifelines and improvements

Overview of categorical and/or numerical data (semantic zoom)

Plaisant, CHI 96, AMIA 98



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Overview of categorical and/or numerical data (semantic zoom)

Plaisant, CHI 96, AMIA 98

The screenshot displays a medical lifeline interface for a patient named Linda Simpson, Female. The lifeline shows a timeline from 1992 to 1997 with various medical events categorized into Notes (Tobacco, Depression, Lyme, Arthritis, Obesity), Hosps (Appendectomy), Tests, Meds (Prozac), and Immun. A central window titled 'i2b2 Workbench for Demo Project' is overlaid, showing a search for 'asthma' and a list of search results. The results include terms like 'Asthma, unspecified', 'Asthma, unspecified with status asthmaticus', and 'Chronic obstructive asthma'. The interface also shows a patient list at the bottom and a 'Patient Set' of 27 patients.

**i2b2 (Murphy, AMIA 07)**

# Lifelines and improvements

Overview of categorical and/or numerical data (semantic zoom)

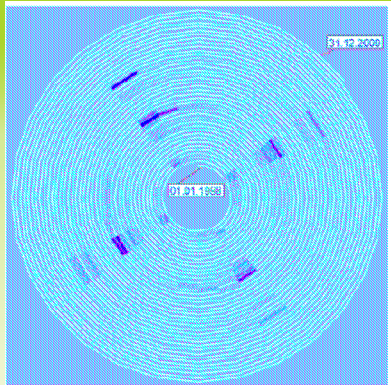
Plaisant, CHI 96, AMIA 98

This screenshot shows the same medical lifeline interface as above, but with a more detailed visualization overlaid on the right side. This visualization includes a timeline with colored bars representing different medical events, a human figure with internal organs highlighted, and various data points and charts. The 'i2b2 Workbench' window is still present in the center, showing the search results for 'asthma'. The overall interface is more complex and data-rich than the previous version.

**i2b2 (Murphy, AMIA 07)**

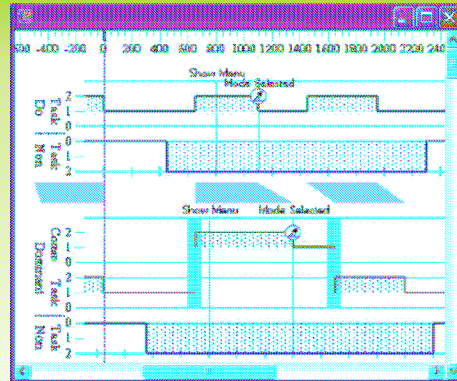
**Bade, CHI 2004**

## Alignment Inspirations



**Spiral Graph: Weber, 01**  
(based on Carlis, UIST 89)

Periodic data

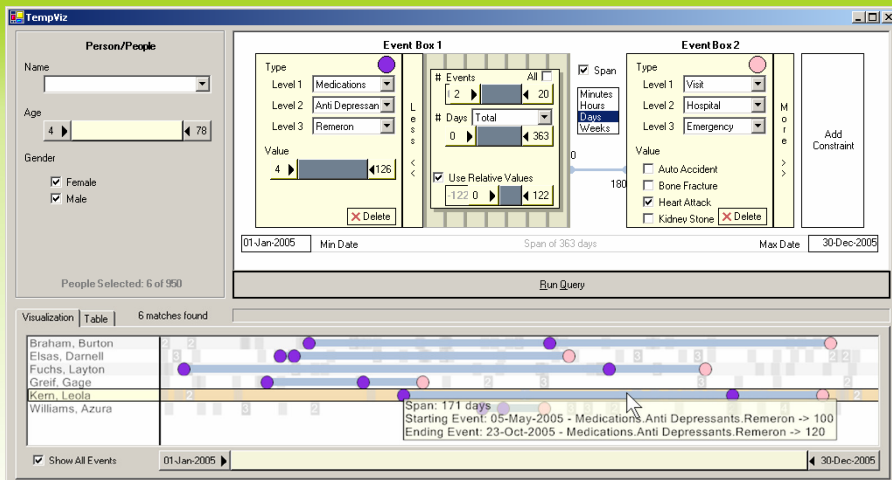


**ExperiScope (Guimbretiere, CHI 07)**  
One of many example of manual alignment



## PatternFinder

Specification of complex temporal queries on categorical data



**Fails, VAST 06**



Ball and chain display of matches

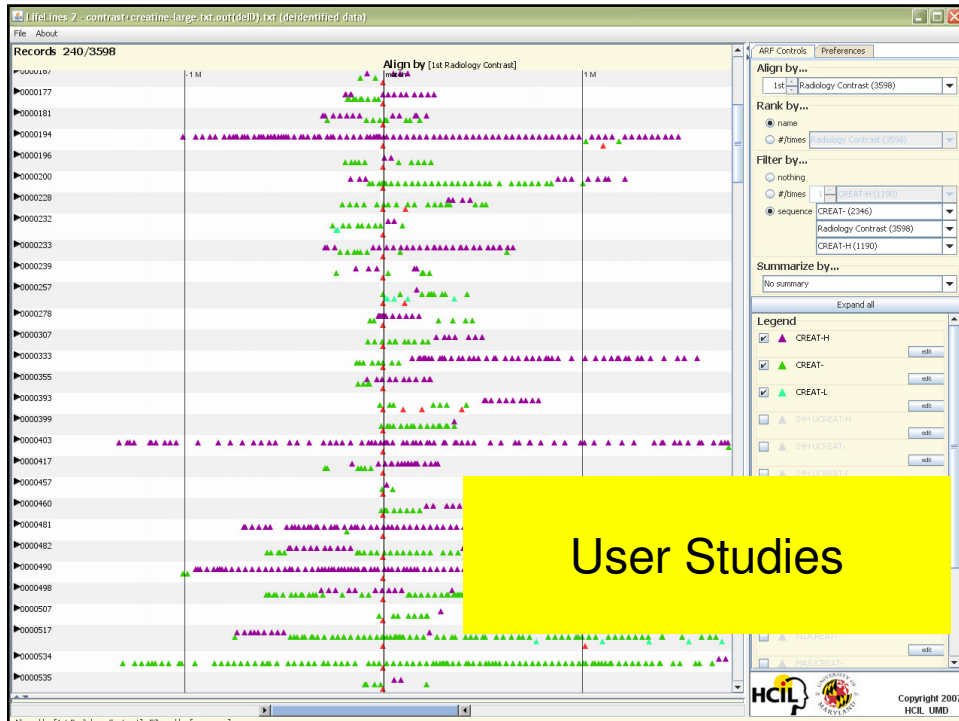
- Sample of Related Work
- **Demo LifeLines2**
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Demo







## Two user studies

- Controlled experiment on Alignment (some training, measure speed and error)
  
- Domain expert qualitative study (no training, think aloud, discussion)





## Two user studies

- **Controlled experiment**  
(some training, measure speed and error)
  - Benefit of alignment: **YES** (Significant improvement on complex tasks)
  - 20 participants: grad students
  - Data: synthetic student record data  
Tasks checked as domain independent
- **Domain expert qualitative study**  
(no training, think aloud, discussion)

[Details](#)

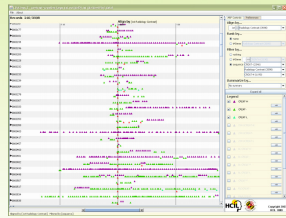
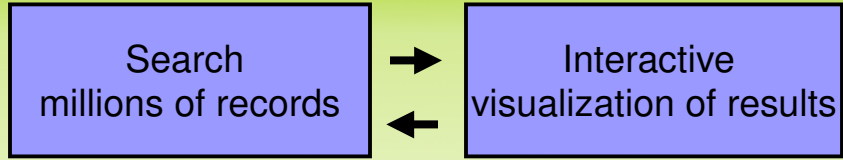


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  - 20 participants: grad students  
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- **Domain expert qualitative study**  
(no training, think aloud, discussion)
  - Learnability: **GOOD**
  - General feedback and suggestions [Suggestions](#)
  - 4 participants: nurse, physician, 2 prof. of nursing
  - All experienced with EHR and medical research



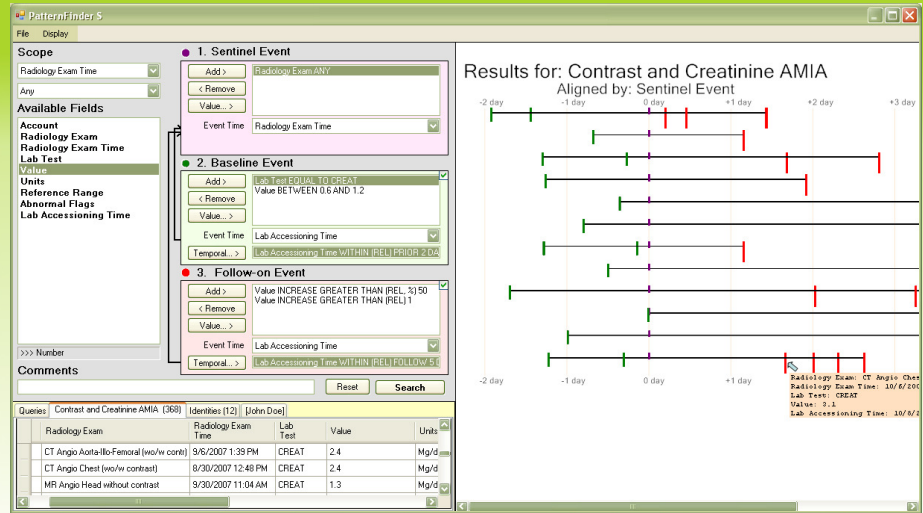
# Context



LifeLines2



# Combine Alignment with PatternFinder



Washington Hospital Center

# Integrate Align-Rank-Filter in i2b2



Harvard Medical School, Partners HealthCare

## In summary...

- **Align Rank, Filter, and Summarize**  
Powerful combination of simple operations to explore temporal categorical data (events)
- **Performance benefit of alignment: significant**
- **Impact:** Deployment in 2 large operational EHR systems
- **Many applicable domains:**
  - Highway incident log
  - Student records
  - Web logs
  - Vehicle fleet records



HCIL Human-Computer Interaction Lab University of Maryland

search

News + Events About HCIL People Research Publications Academics

quick find :: Current Research Projects

20+ years of Tech Report Online

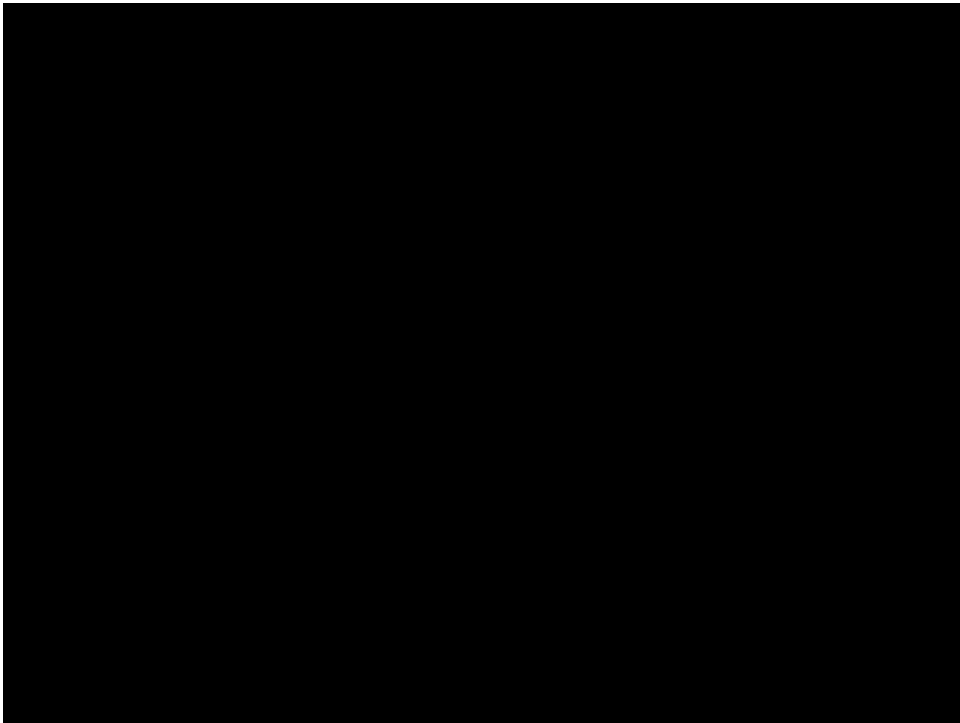
15+ years of Video Reports

NEWS

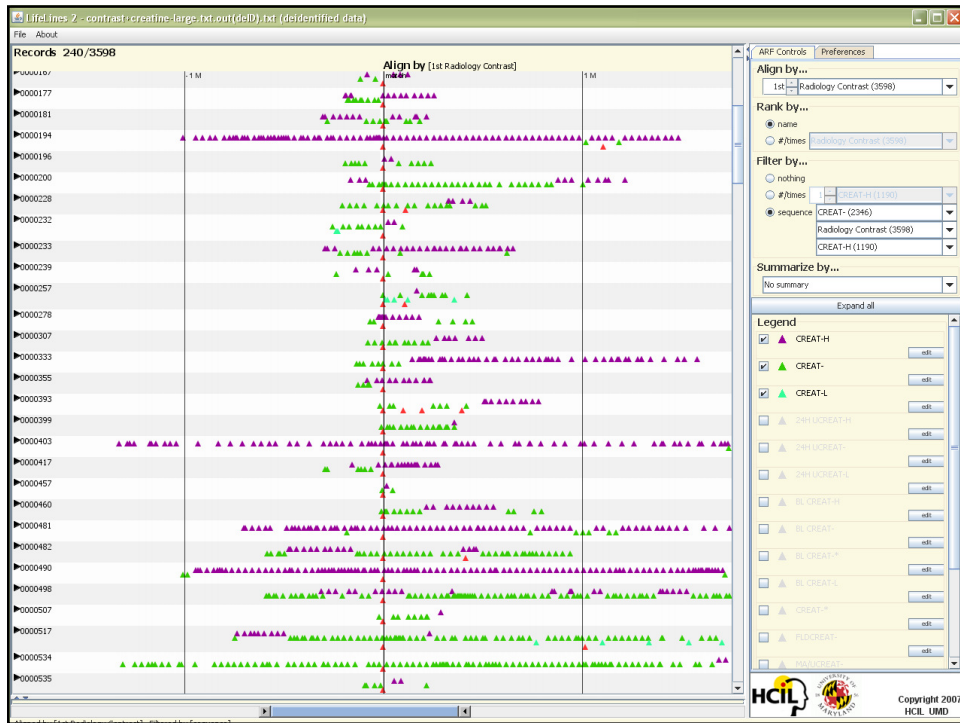
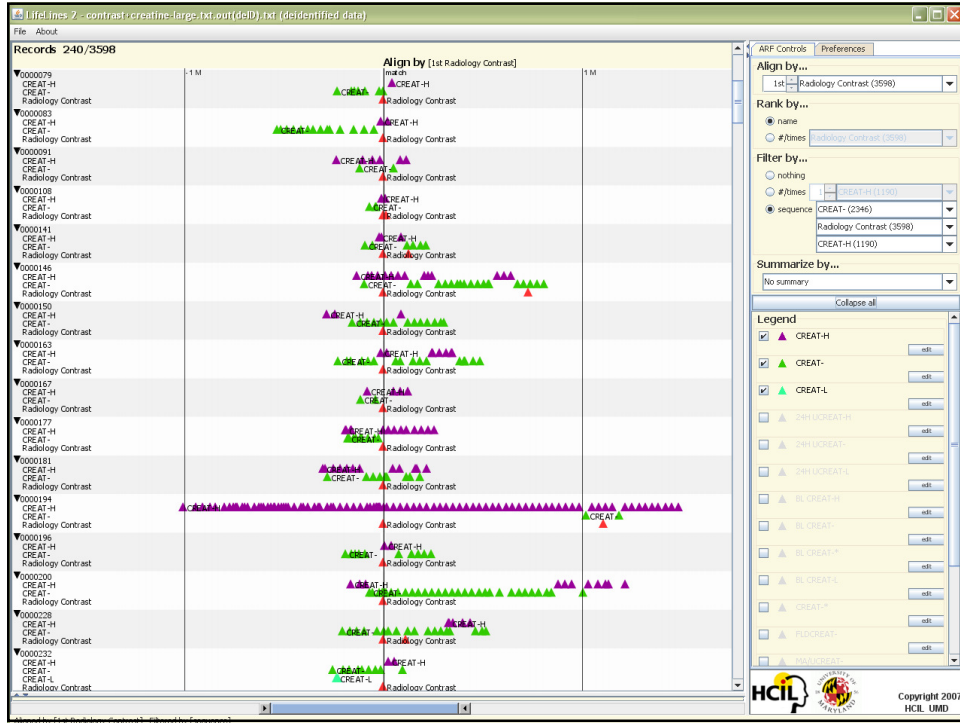
20+ years of research, publications, and resources

# Thank you!

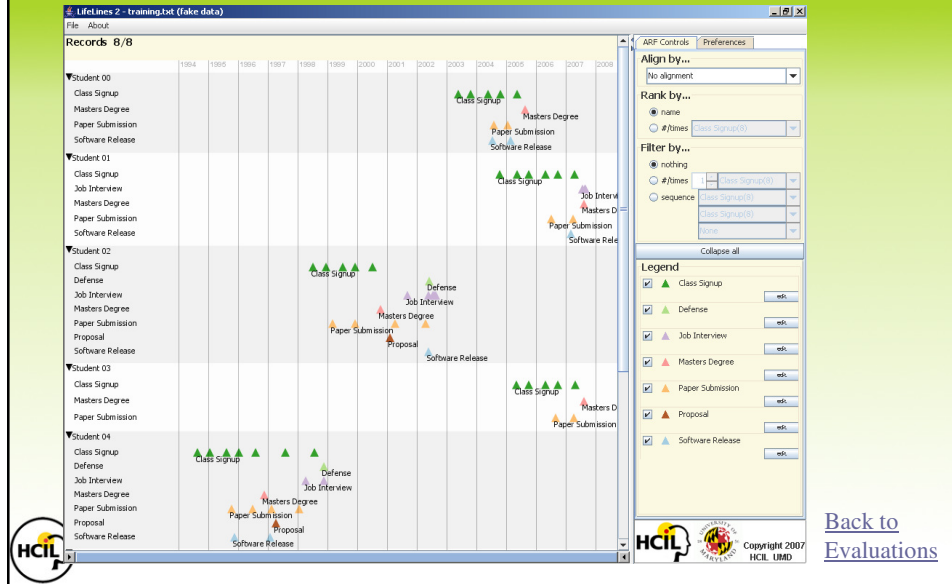
[www.cs.umd.edu/hcil/lifelines2](http://www.cs.umd.edu/hcil/lifelines2)







## Quant. Evaluation Sample Data



## Quantitative Evaluation Tasks

**Task 1:** How many students submitted a paper within 1 month after proposal? (5 records)

**Task 2:** How many students submitted a paper within 1 month after proposal? (20 records)

**Task 3:** How many students submitted at least 3 papers between proposal and defense?

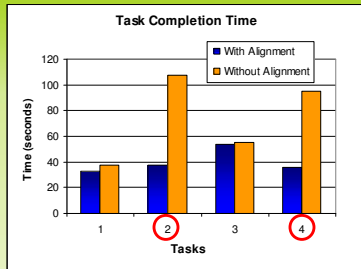
**Task 4:** What occurred most often within a month of a student's 1<sup>st</sup> paper submission?



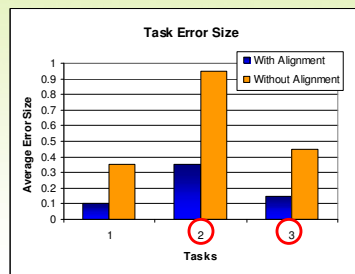
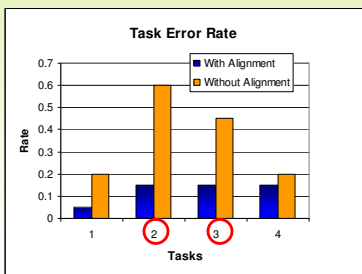
[Back to Evaluations](#)



# (Alignment vs. No Alignment)



- RM 1-way ANOVA
- Counter-balanced
- Very helpful (8.3)



[back](#)

# TimeSearcher

Dynamic queries on numerical temporal data

The screenshot displays the TimeSearcher application window. The top window shows a time-series plot of closing prices for ESAT TELECOM, with a list of 9 data points. The bottom window shows a time-series plot of SUNLIGHT data with a highlighted red region and a 21% annotation. A third window shows a list of variables including SUNLIGHT, PUGLIA\_CITIES, and various locations like ANCONIA, BARI, etc.

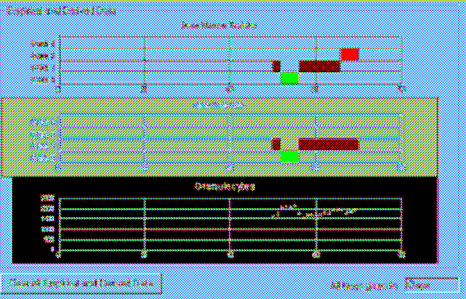
Hochheiser Infovis04

Buono VDA05



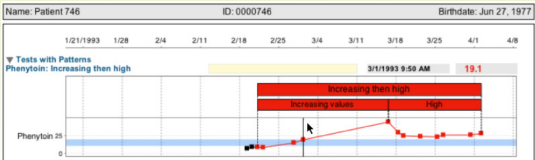
[www.cs.umd.edu/hcil/timesearcher](http://www.cs.umd.edu/hcil/timesearcher)

Specification of temporal abstractions  
To reason/query with them



Shahar 1999

Post 2007



No focus on interaction

