

Information Visualization

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SINI – July 21, 2016

First, THANK YOU

Maryland Colleagues

Ben Shneiderman

Sana Malik

Fan Du

Tiffany Chao

Megan Monroe, Krist Wongsuphasawat, David Wang, and many other past students

All other colleagues whose work is included here



www.cs.umd.edu/hcil

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Human-Computer Interaction Lab

Interdisciplinary Research Community

Computer Science

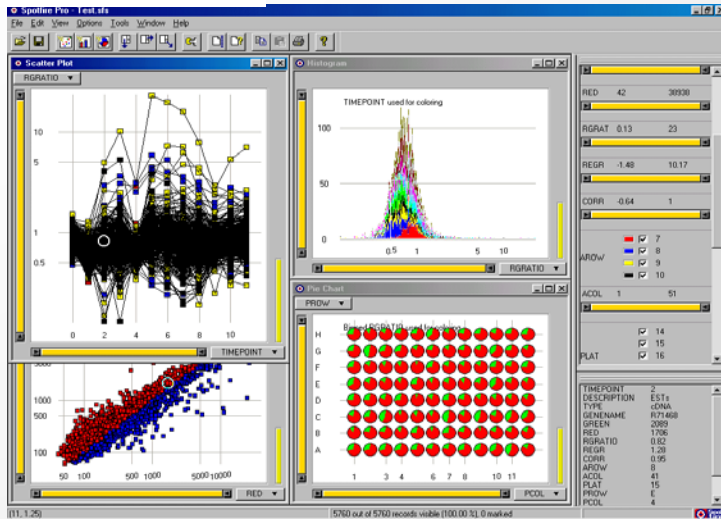
Information Studies

Psychology, Sociology, Engineering

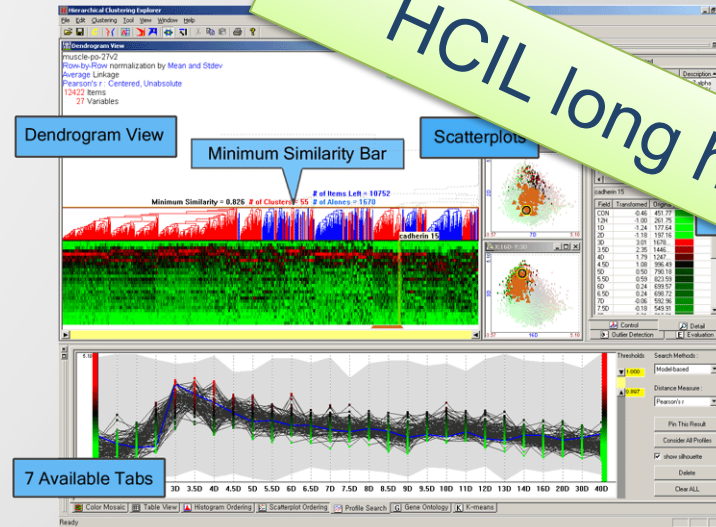
etc.

hcil.umd.edu

Information visualization

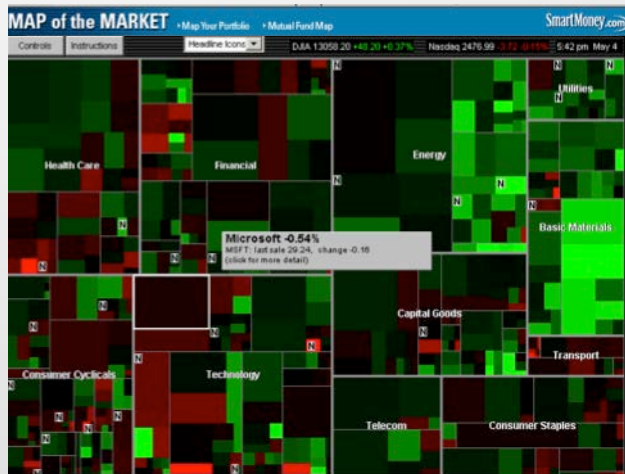


Filmfinder prototype lead to SpotFire commercial tool

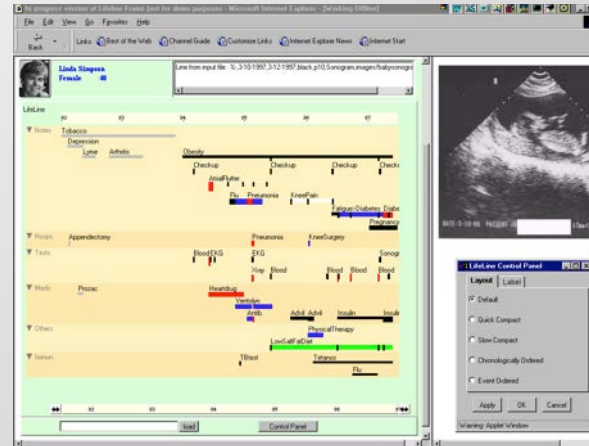


Hierarchical Clustering Explorer HCE

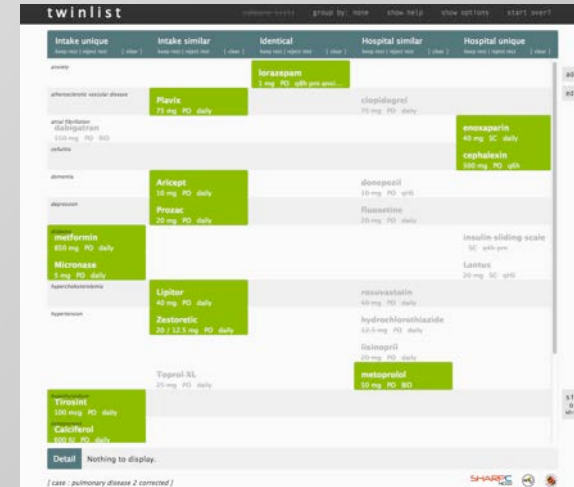
HCIL long history



Treemap



Lifelines



Twinlist for medication reconciliation

SEEING AS UNDERSTANDING

A common metaphor

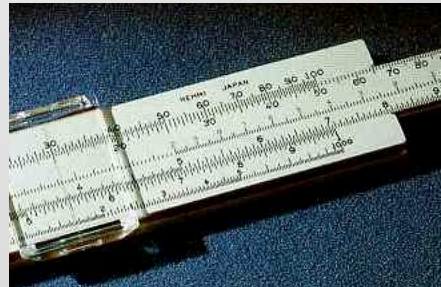
- “I see what you mean”
- “to bring an issue in focus”
- “to make an idea clear”

SEEING AS UNDERSTANDING

A common metaphor

- “I see what you mean”
- “to bring an issue in focus”
- “to make an idea clear”

$$\begin{array}{r} 129 \\ +205 \\ \hline =334 \end{array}$$



blue black blue black black black black
blue black blue black black black black
blue black blue black black blue black
blue black black black black blue black
blue red black blue black blue black
black black black blue black blue black
black black black blue black blue black
black

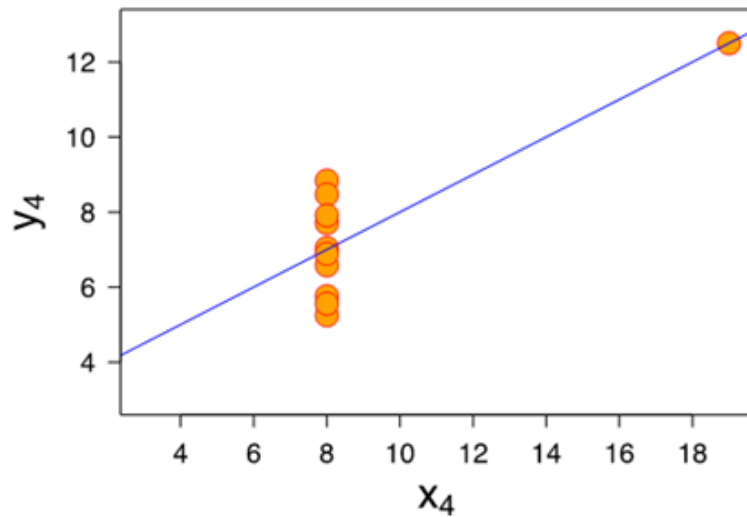
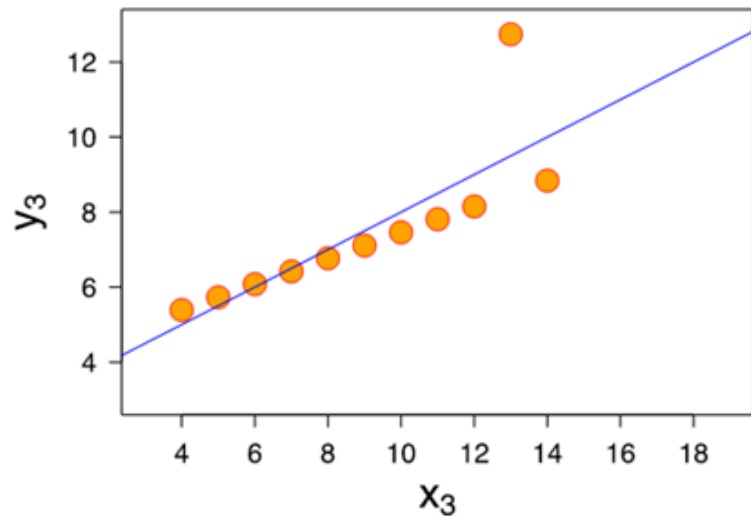
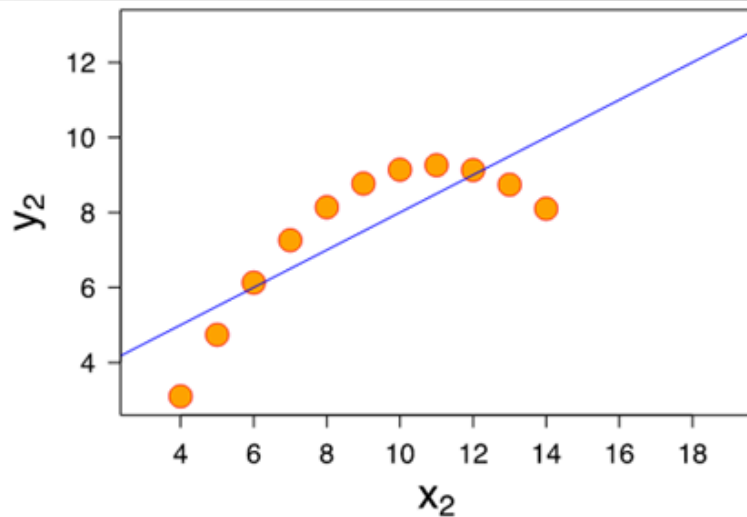
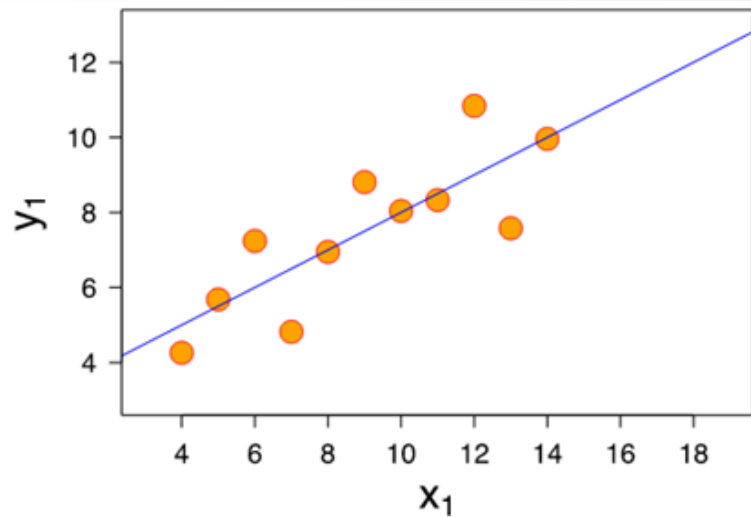
ANSCOMBE'S QUARTET

1		2		3		4	
x	y	x	y	x	y	x	y
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

For ALL 4 datasets

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



INFORMATION VISUALIZATION

Interactive

Compact graphical presentation and user interface

for manipulating large numbers of items ($10^2 - 10^6$),

Enables users to make discoveries, decisions, or explanations about patterns or groups of items

- **Visual bandwidth is enormous**
Human perceptual skills are remarkable

Part 1: Visualization of Electronic Health Record data



A SINGLE RECORD

What is the situation?
What has been done?
What should we do now?



MULTIPLE RECORDS

RECORD

RECORD

RECORD

RECORD

RECORD

Are we following guidelines?

Do you have patients for my clinical trial?

Retrospective analysis:

How are opioids prescribed?

Patterns of readmissions?

Drug adverse reactions?

How can we improve care?



1996

In progress version of LifeLine Frame [not for demo purposes - Microsoft Internet Explorer - [Working Offline]

File Edit View Go Favorites Help

Back Links Best of the Web Channel Guide Customize Links Internet Explorer News Internet Start

Linda Simpson
Female 40

Line from input file: %:3-10-1997,3-12-1997,black,p10,Sonogram,images/babysonogra

LifeLine

92 93 94 95 96 97

Notes
Tobacco
Depression
Lyme Arthritis
Obesity
AtrialFlutter
Flu Pneumonia KneePain
Fatigue>Diabetes Diabe
Pregnancy

Hosps. Appendectomy
Pneumonia KneeSurgery

Tests
BloodEKG EKG
Xray Blood
Blood Blood Blood

Meds. Prozac
Heartdrug
Ventolyn
Antib. Advil Advil Insulin Insulin

Others
PhysicalTherapy
LowSaltFatDiet

Immun.
TBtest
Tetanus
Flu

LifeLine Control Panel

Layout Label

Default
 Quick Compact
 Slow Compact
 Chronologically Ordered
 Event Ordered

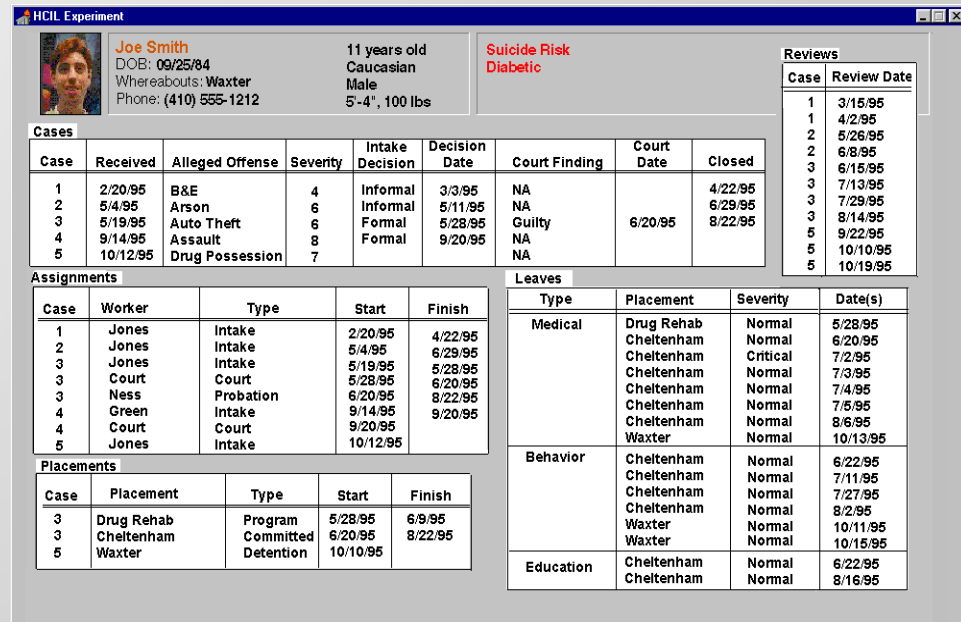
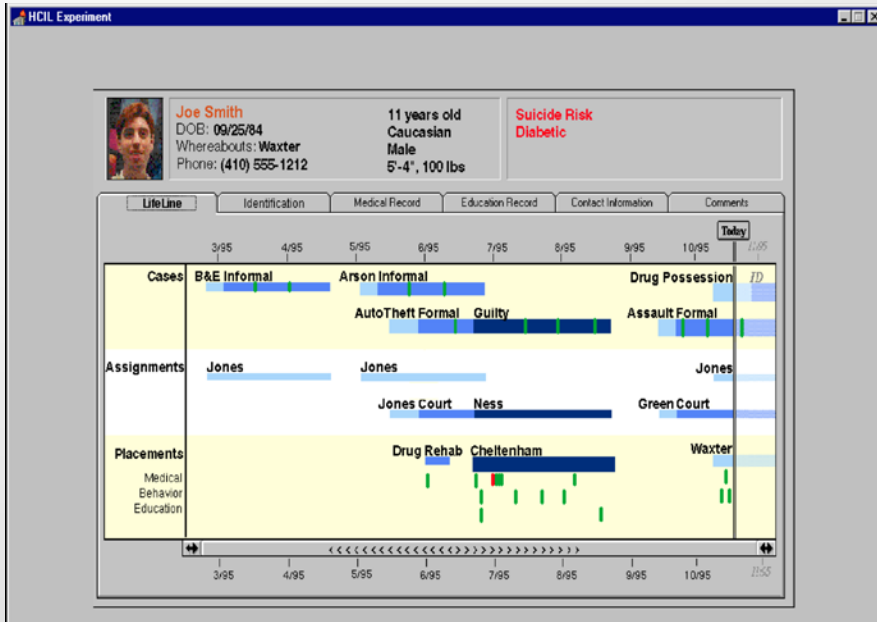
Apply OK Cancel

Warning: Applet Window

LifeLines – Single Patient
<http://www.cs.umd.edu/hcil/lifelines>

STRONG BENEFITS

- LifeLines twice as fast for many tasks (time interval comparison or inter-categorical information tasks)
- Better recall (out of 6 questions: 4.3 vs 2.8 correct)
- More accurate “1st impression”



BACK
SEARCH
LAST 10
NEW PT
NOTE
SINGLE
DSKTP
ADMIN
APPTS
FAX
MSG
ROUTE
HELP
CLOSE CHART
SWITCH USER
EXIT EMR

Bradley J. Reynolds 58 yo Male 03/30/1950 207 lbs / 94 kg

Primary Ins: **United Healthcare**
 Secondary: **Blue Cross Blue Shield**

Primary Care: **Roger K. Hall, M.D.**
 Referring Provider: **Howard W. Follis, M.D.**

Address: **100 South Street
 Springfield, MO 65807**

Home: **(417) 555-9184**
 Work: **(417) 555-3323**
 Cell: **(417) 555-2326**



Timeline

Open O.V. Note

Documents

Chart Management

Demographics

Allergies

IVP Dye

Aspirin

Medications

Avodart 0.5mg ...	1...	PO	QD
Cialis 20mg tablet	1	PO	QD
Ditropan xl 15m...	1	PO	QD
Hctz 25mg tablet	1	PO	QD
Proscar 5mg tablet	1	PO	QD
Accupril 40mg t...	1	PO	QD
Allegra 180mg t...	1	PO	QD
Glucophage 500...	1	PO	QD
Lipitor 20mg tablet	1	PO	QD

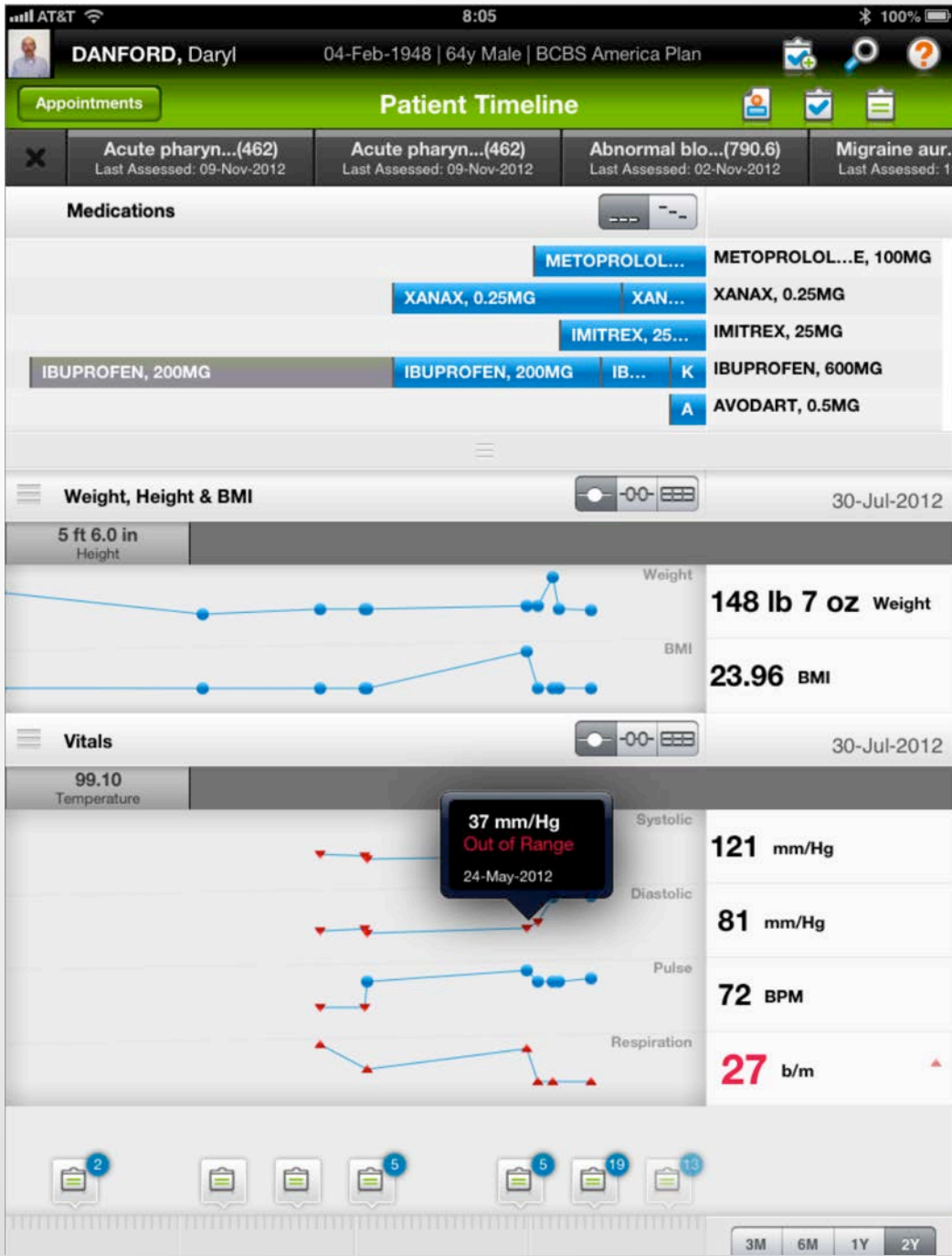
Surgical History

Medical History

Family History

Social History





The Wand Timeline view of a patient record in Allscripts's ambulatory EHR iPad application. Used with permission of Allscripts.

MULTIPLE RECORDS

RECORD

RECORD

RECORD

RECORD

RECORD



The screenshot displays the i2b2 Workbench interface for a demo project. The main window is titled "i2b2 Workbench for Demo Project" and shows a "Query Tool" window with a query name "Pneumon-Asthma@11:56:24". The query tool includes three groups for defining the query: Group 1 (Pneumonia and influenza, Other bacterial pneumonia), Group 2 (Asthma), and Group 3 (empty). The "Timeline View" window shows a visualization of the query results for three patients, with a timeline for each patient showing events for Pneumonia and Asthma. The timeline view includes a "Patient Set" of 37 patients, a "start" value of 1, and an "increment" of 37.

Query Tool Configuration:

Group	Group Name	Dates	Occurs > 0x	Exclude
Group 1	Pneumonia and influenza Other bacterial pneumonia			
Group 2	Asthma			
Group 3				

Timeline View Data:

Patient ID	Demographics	Timeline Events
Person #1000000008	Male, 20yroid, Hispanic	Pneumonia (yellow bars), Asthma (green bars)
Person #1000000009	Female, 18yroid, Hispanic	Pneumonia (yellow bars), Asthma (green bars)
Person #1000000012	Female, 16yroid, Black	Pneumonia (yellow bars), Asthma (green bars)
Person #1000000013	Female, 80yroid, Black	Pneumonia (yellow bars), Asthma (green bars)

Previous Queries List:

- Pneumon-Asthma@11:56:24 [04-07-2008] [demo]
- Pneumonia and i@11:55:18 [04-07-2008] [demo]
- Antit-Chemi-Age@05:30:12 [02-20-2008] [demo]
- (+) Female-Asthma@11:32:46 [02-08-2008] [demo]
- Female-Asthma@11:18:56 [02-08-2008] [demo]
- (+) Female-Asthma@11:16:52 [02-08-2008] [demo]
- 0-9 y-Femal-Respi@10:10:01 [01-16-2008] [demo]
- 0-9 y-Male-Intri@02:26:19 [01-07-2008] [demo]
- Female-Asthma,@00:14:43 [01-07-2008] [demo]
- Combined immuni@04:15:57 [12-20-2007] [demo]
- 0-9 y-Femal-Black@04:10:52 [12-20-2007] [demo]
- 0-9 yea-Female@04:10:09 [12-20-2007] [demo]
- 0-9_hutton [12-20-2007] [demo]
- Hutton_0 [12-20-2007] [demo]
- Here is my proposal to ich [12-20-2007] [demo]

Numerical

Patient ID: 12345

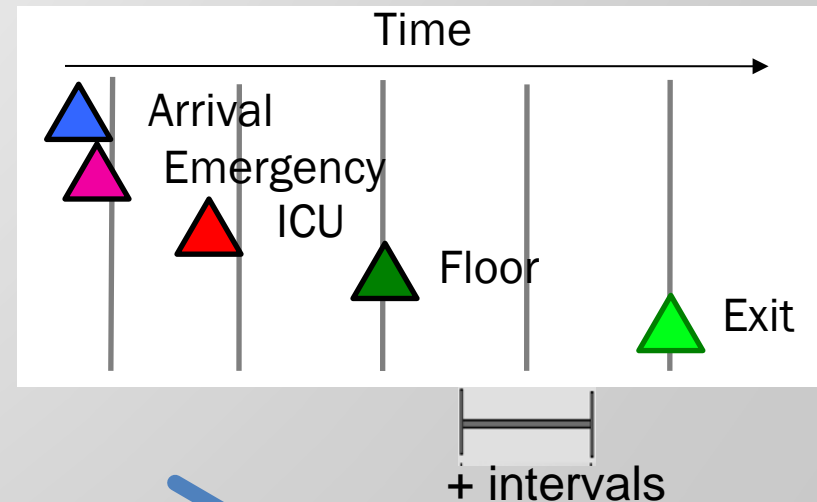
04/26/2010 10:00	31.03
04/26/2010 10:15	31.01
04/26/2010 10:30	31.02
04/26/2010 10:45	31.08
04/26/2010 11:00	31.16



Categorical

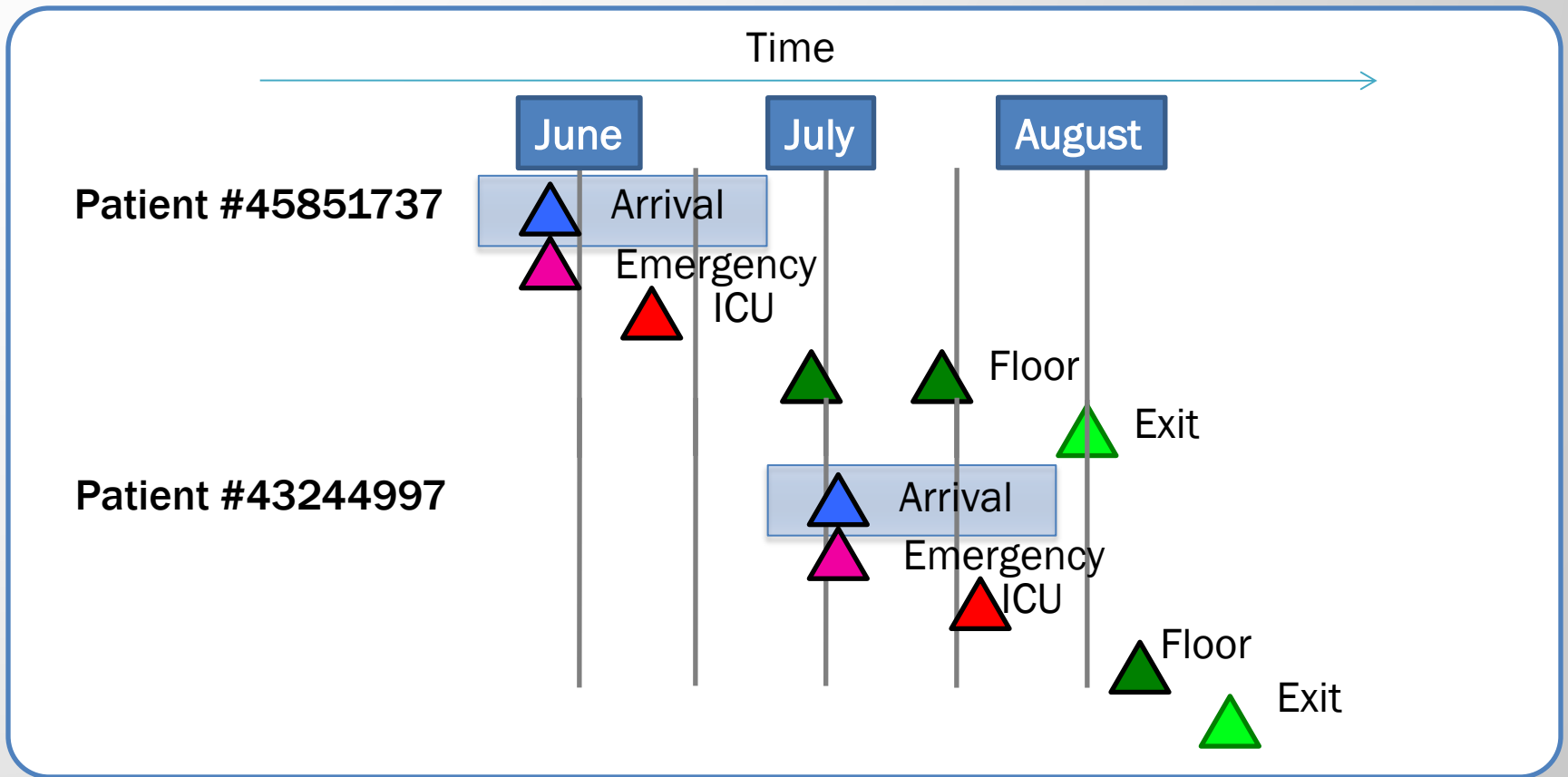
Patient ID: 45851737

12/02/2008 14:26	Arrival
12/02/2008 14:36	Emergency
12/02/2008 22:44	ICU
12/05/2008 05:07	Floor
12/14/2008 06:19	Exit

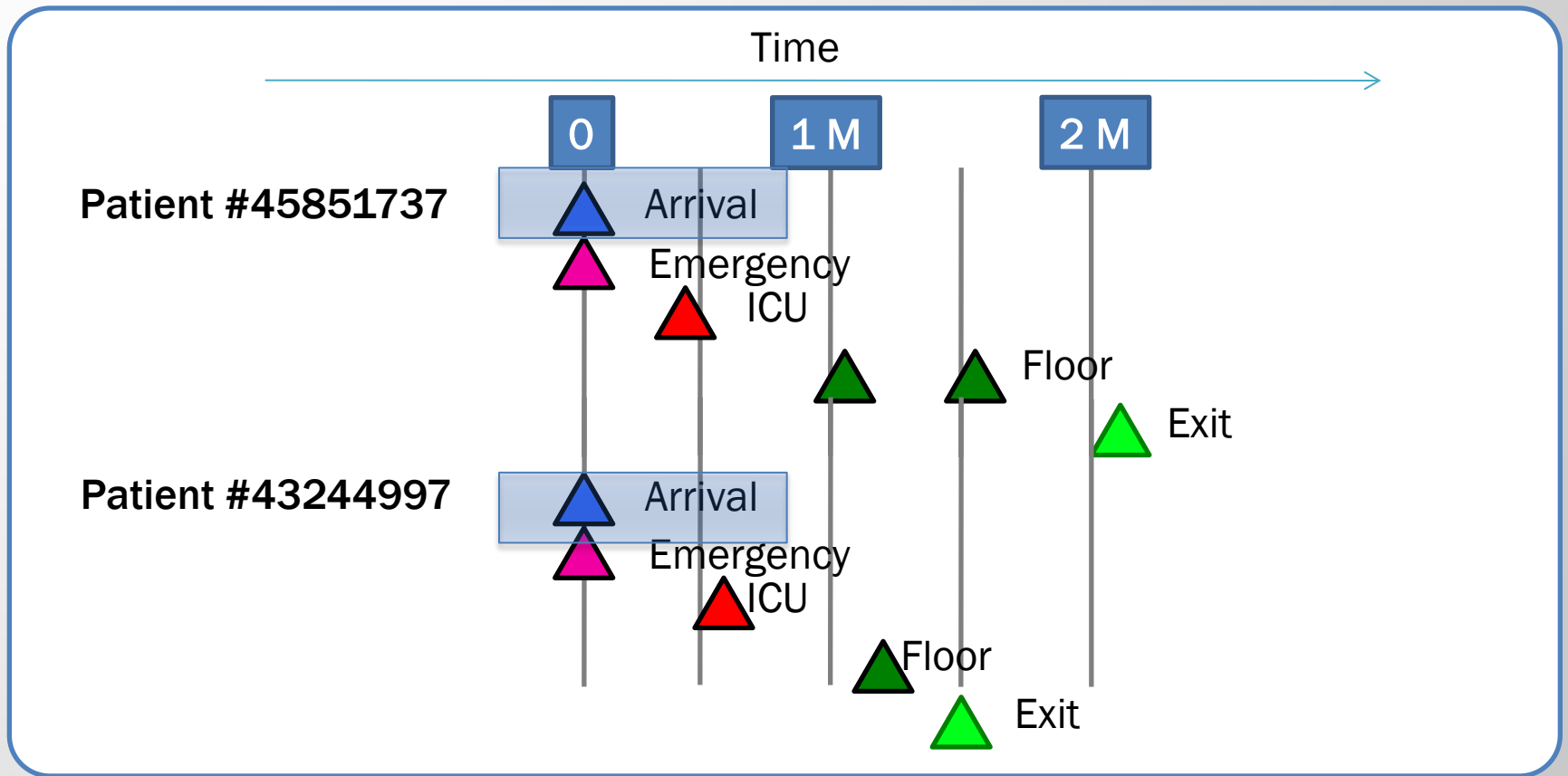


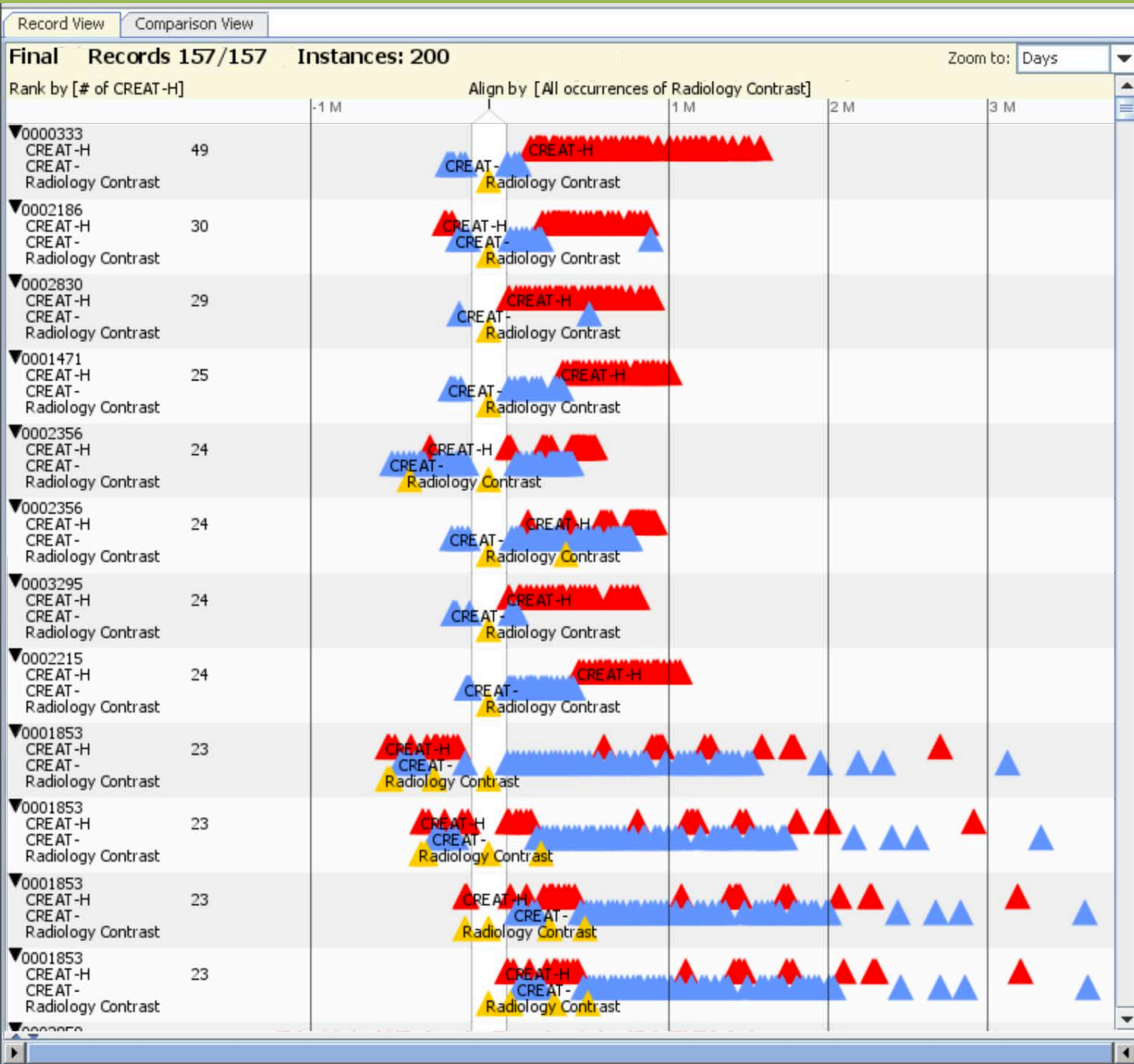
e.g. High/Normal/Low

ALIGNMENT



ALIGNMENT





ARF Comparison

Align by...

▲ Radiology Contrast(3598)

1st occurrence

Rank by...

▲ # of CREAT-H(1190)

Filter by...

No Filter

Keep Selected Remove Selected

Reset Filters

Show Distribution of...

None

None

None

View Record Group...

All Records

Collapse all Save Records as New Group

Events Icons Labels Alignment

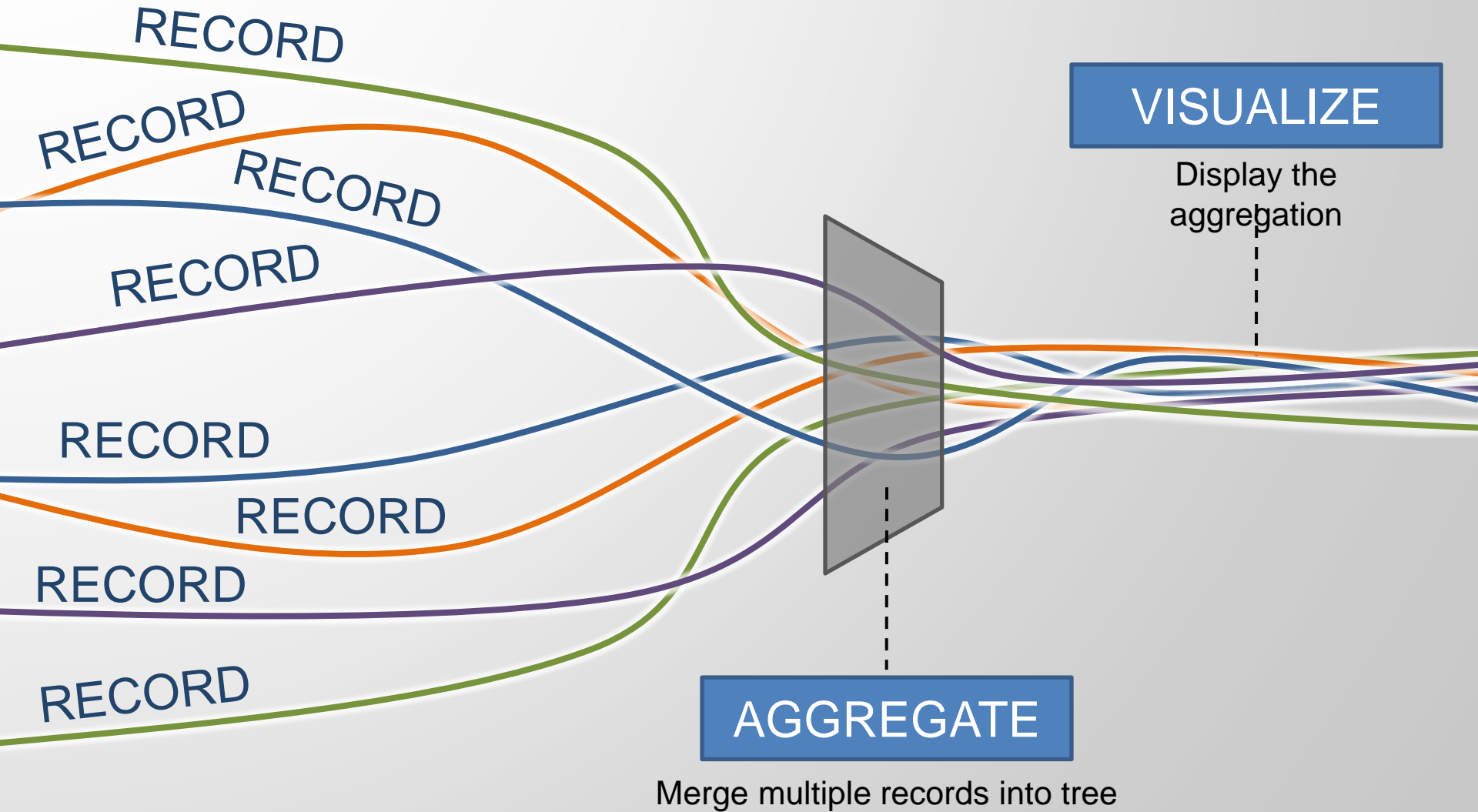
Legend

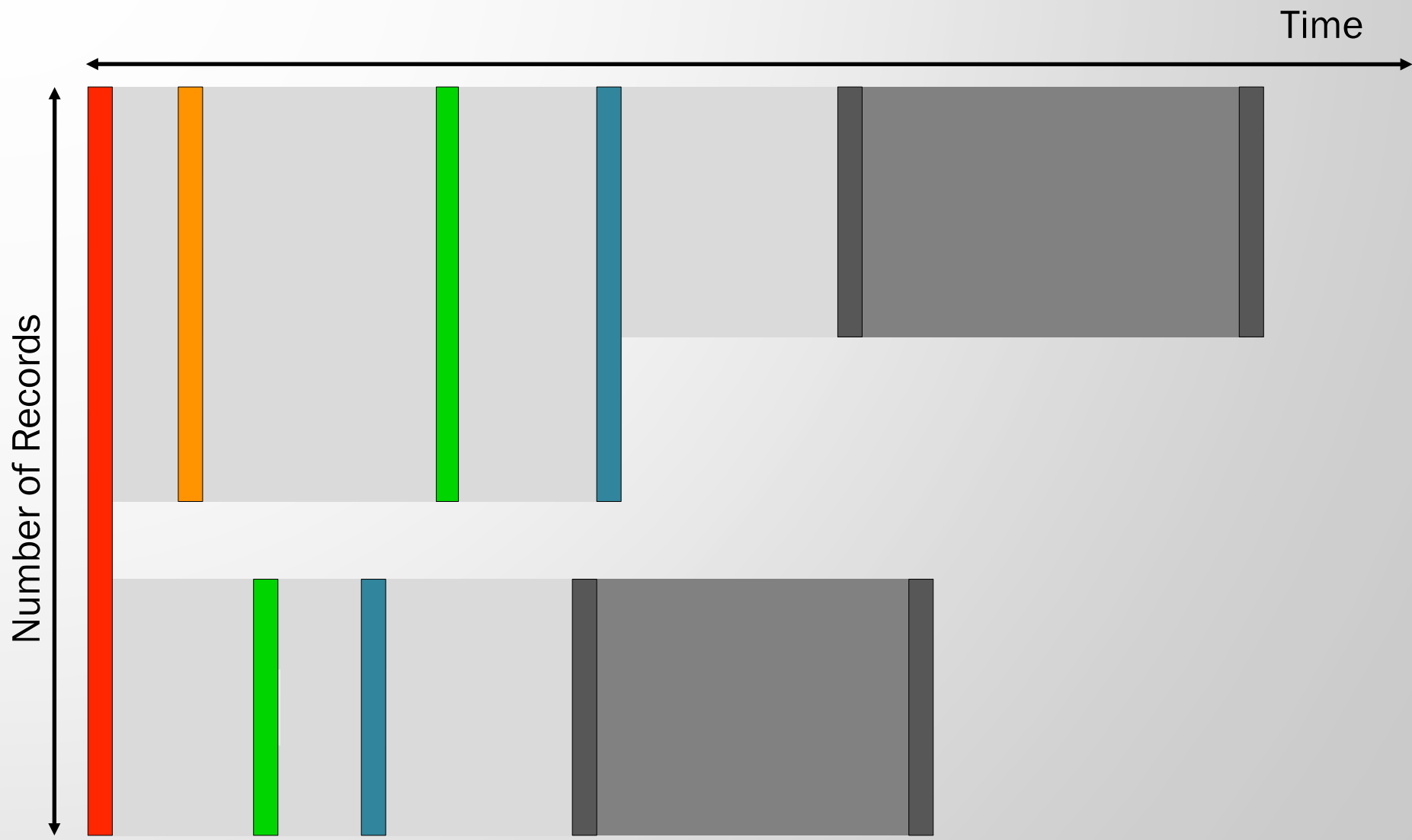
- ▲ CREAT-H edit
- ▲ CREAT- edit
- ▲ CREAT-L edit
- ▲ 24H UCREAT-H edit
- ▲ 24H UCREAT- edit

HCIL UNIVERSITY OF MARYLAND

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OVERVIEW OF EVENT SEQUENCES







Show all records

Select visibles

Hide selected

Deselect all

Hide others

100 records

100 visibles

0 selected

Choose 2

Align

Merge

Window

No alignment

1 st

from the beginning

All

Focus:

Before Both After

Advanced Options...

(no advanced option selected)

automatic update

Align

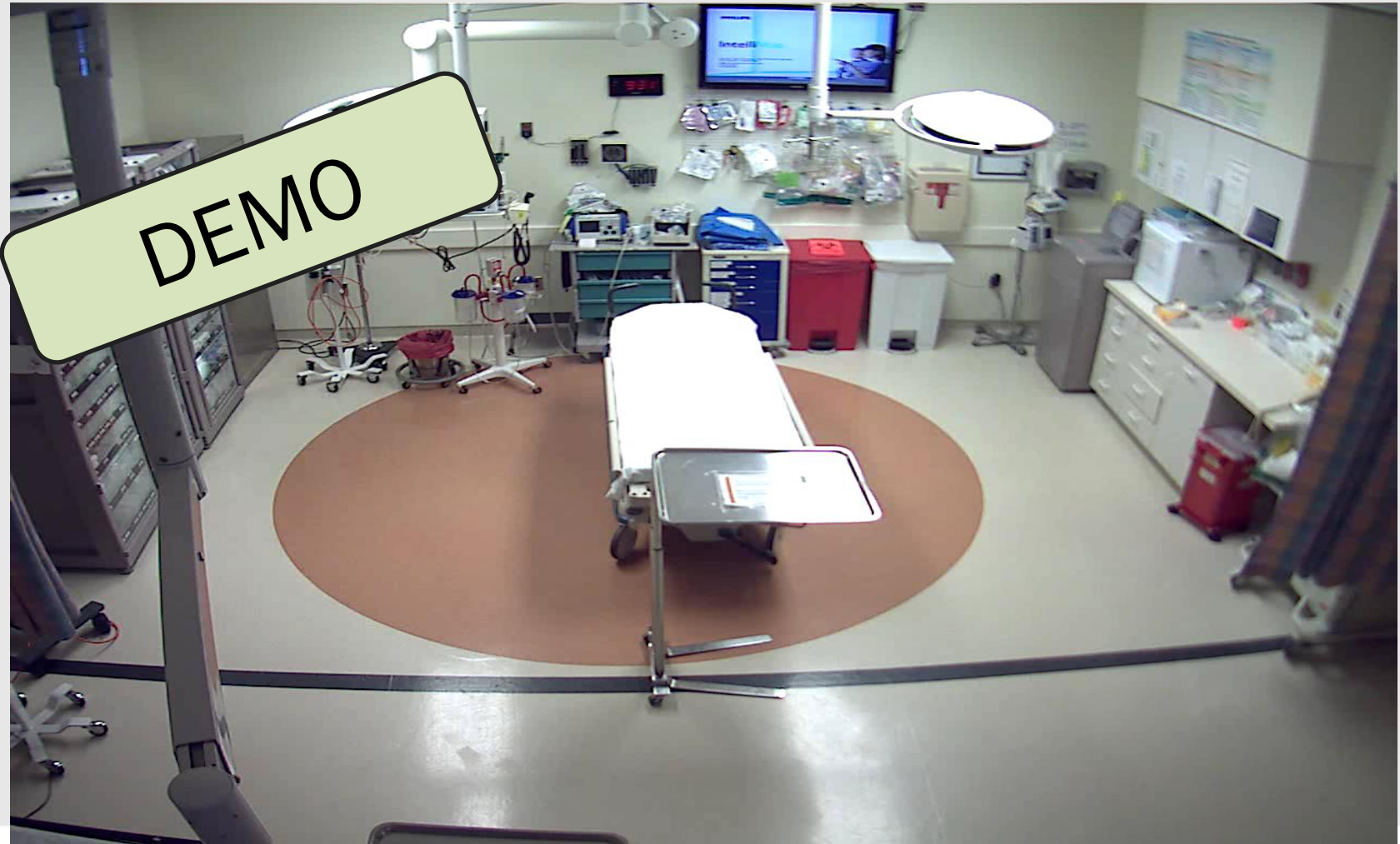
Select All

Deselect All

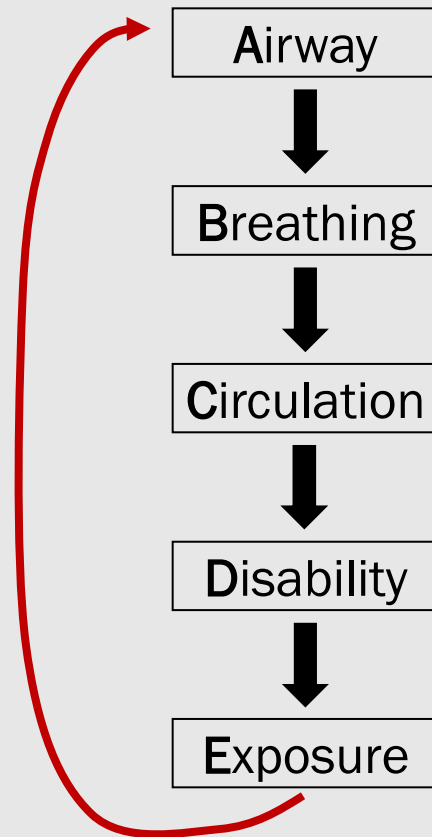


Zoom: 3 Months

Task Performance During Pediatric Trauma Resuscitation

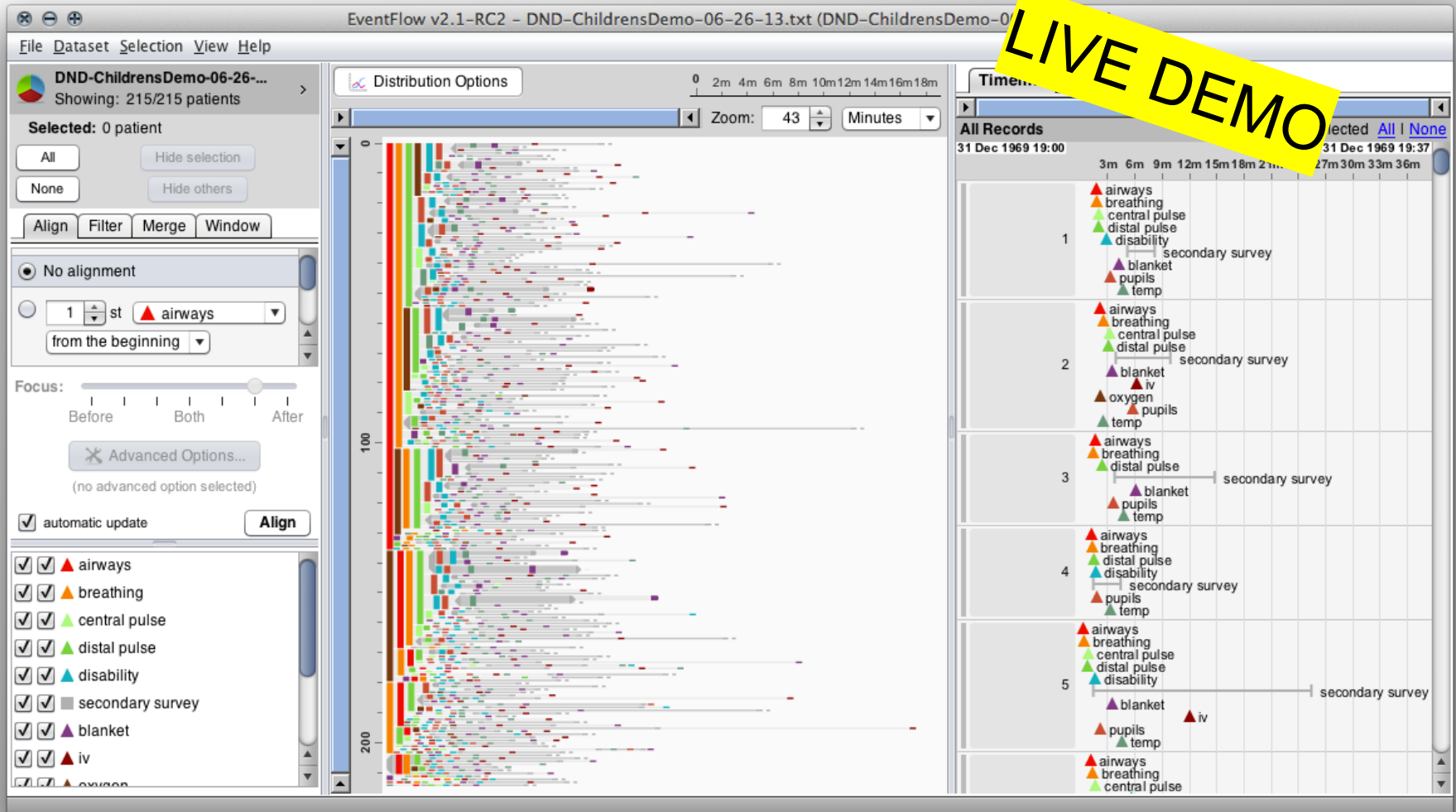


Primary Survey



Identify and manage
life-threatening
conditions in a
sequential manner
ABCDE

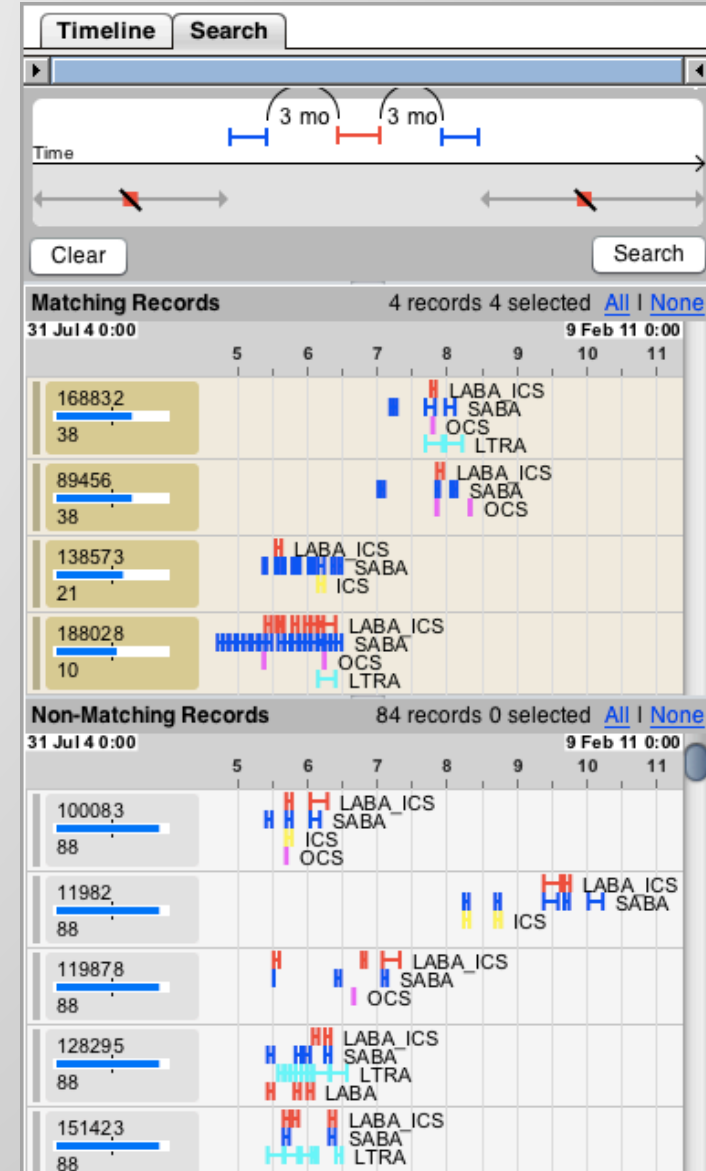
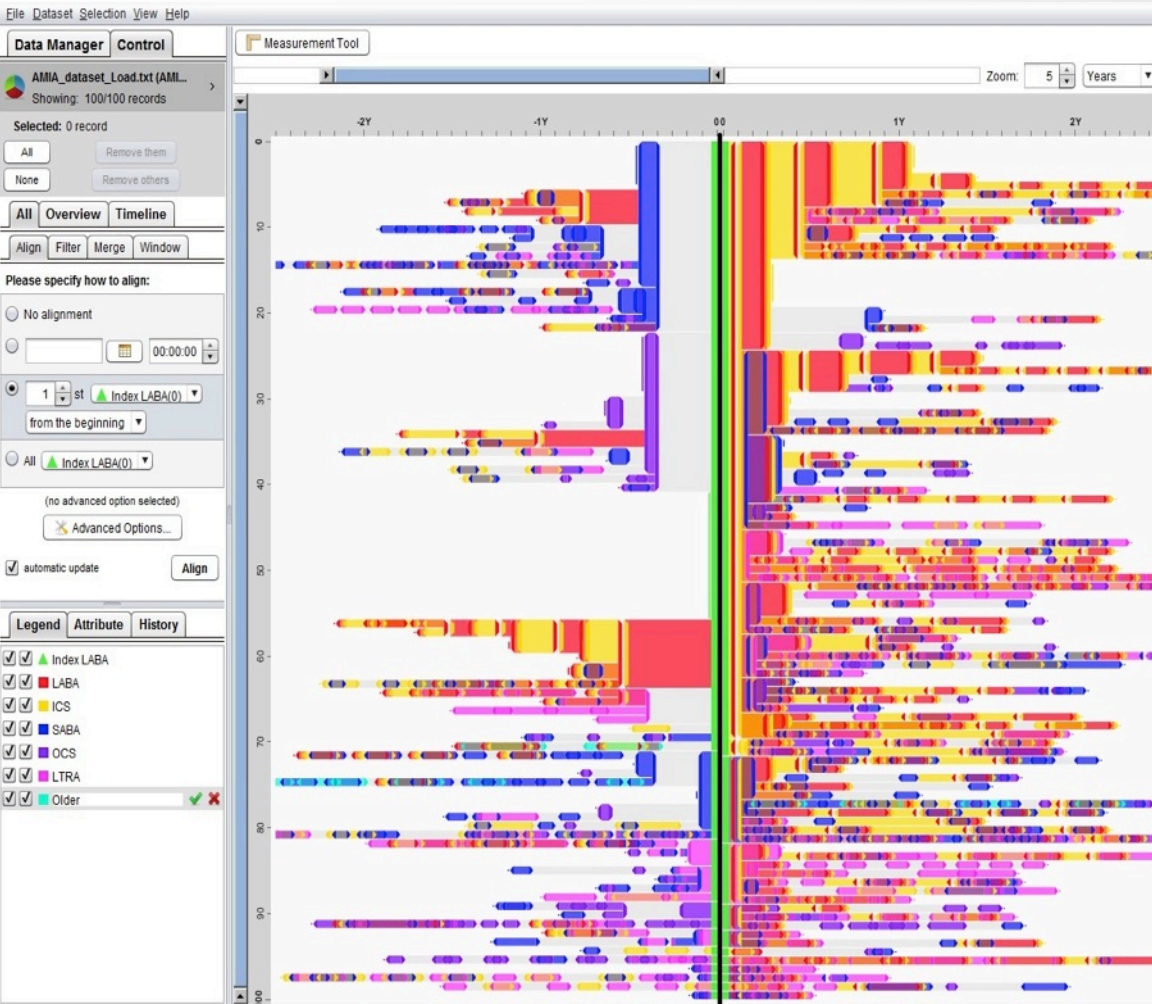
EventFlow consists of 3 panels: (1) a control panel and legend on the left for filtering and other display options, (2) the aggregated overview in the middle showing all 250 patient records, and (3) the timeline view on the right which shows details for each patient on each row



skip

Other example

in collaboration with Army Pharmacovigilance Center
Analysis of prescription patterns of asthma medication



A Visual-interactive System for Prostate Cancer Stratifications

Jürgen Bernard, David Sessler, Thorsten May, Thorsten Schlomm, Dirk Pehrke, and Jörn Kohlhammer

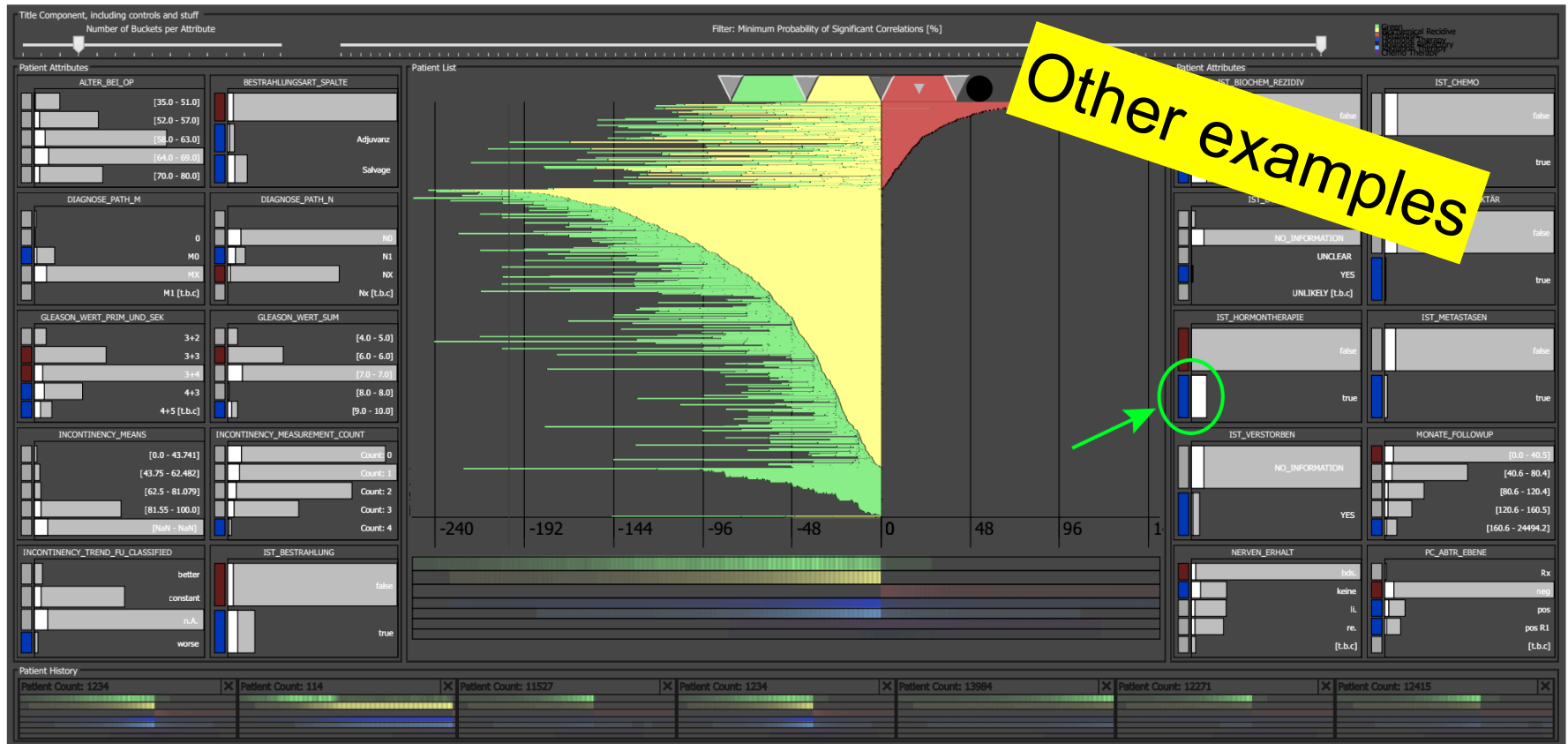


Fig. 1. Current state of the system for visual-interactively browsing in prostate cancer patient histories. It consists of three components. A list-based overview of the patient histories is shown at the center. This has been the first goal of the project. The history of selected patient subsets is shown at the bottom using aggregated views (coined *cohort fingerprints*). To the left and right, the distributions of static attributes are shown, whose observations are related to the current patient set by statistical dependency measures (see arrow).

Top Chart Treemap (caus...)

Cause of Disease or Injury
A.7.2.2. Acute hepatit...

Metric Deaths

Place Global

Year 2010

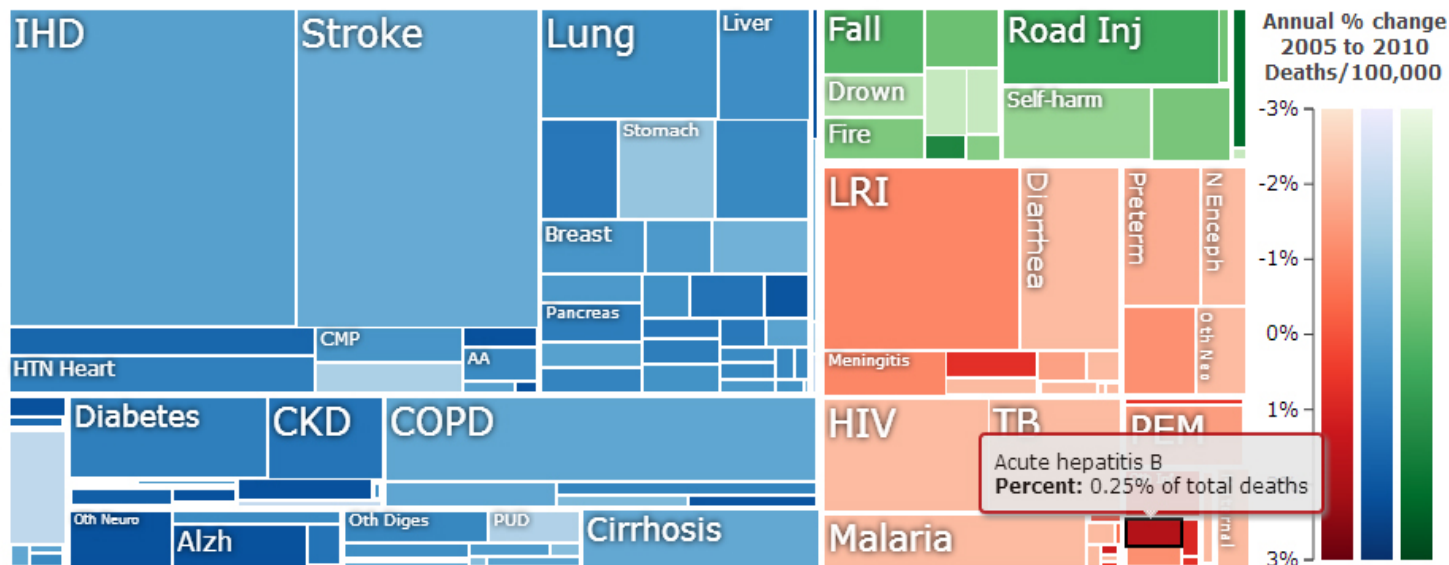
Age All ages

Sex **Both** Male Female

Depth 4

Color ■ Rate of Change

Global, deaths
Both sexes, All ages, 2010



Bottom Chart Map

Display Cause of Disease or I...
A.7.2.2. Acute hepatit...

Metric Deaths

Place Global

Year 2010

Age All ages

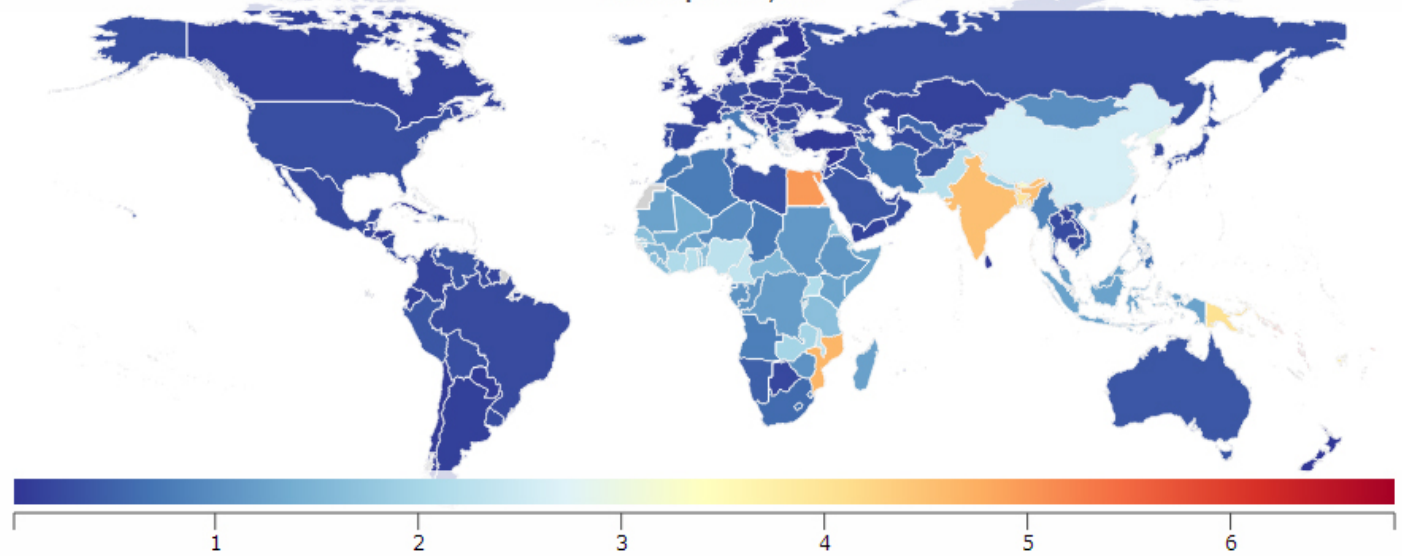
Sex **Both** Male Female

Units # **Rate** %

Mapping Level Country

Zoom - Reset +

Acute hepatitis B
Both sexes, All ages, 2010
Deaths per 100,000



Many useful commercial tools



Buy Sign In English

Products Solutions Learning Support Partners About

FREE TRIAL

Home Products Tableau Desktop

TABLEAU DESKTOP

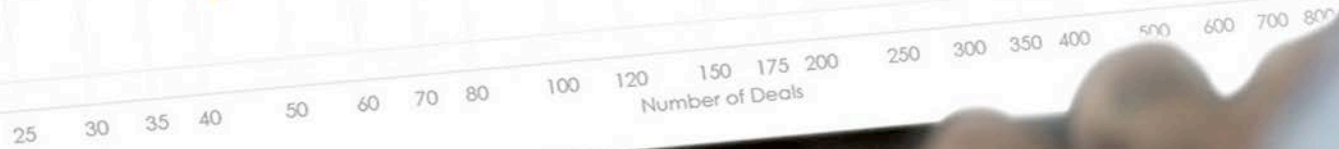
Business analytics anyone can use.

Funding Amount

TRY IT FREE

SEE IT IN ACTION

\$10B
\$3B
\$1B
\$0B
\$0B
\$0B



Overview

Tech Specs

Gallery

FREE TRIAL

TIBCO Spotfire® Desktop

Better Insights Fast

TIBCO Spotfire® Desktop is analytics software designed for data exploration. It enables you to discover and depict critical insights in data that drive real value. Spotfire is software designed for the inquisitive person. Start your free trial today.

TRY FOR FREE



OVERVIEW

SPECIFICATION

WHAT'S NEW

FREE TRIAL

Part 2:

Novel Interfaces for Medication reconciliation





Twinlist: Novel User Interface Designs for Medication Reconciliation

C. Plaisant, T. Chao, J. Wu, B. Shneiderman
University of Maryland, College Park

J. Herskovic, T. Johnson, E. Bernstam, E. Markowitz
University of Texas, Houston

Z. Hettinger

Medstar Institute for Innovation, DC

S. Powsner

Yale University, CT

Intake

keep rest | reject rest [clear]

Acetaminophen

325 mg PO q6h

Calcitrol

0.25 mg PO daily

Darbepoetin

60 mg SC qFriday

Folvite

1 mg PO daily

Meloxicam

7.5 mg PO daily

Ramipril

5 mg PO daily

Hospital

keep rest | reject rest [clear]

Acetaminophen

325 mg PO q4h

Calcitrol

0.25 mg PO daily

Ciprofloxacin

500 mg PO daily

Darbepoetin

60 mg SC qFriday

Ferrous Gluconate

300 mg PO TID

Folic acid

1 mg PO daily

Omeprazole

40 mg PO daily

Ramipril

5 mg PO daily



Intake

keep rest | reject rest [clear]

Acetaminophen

325 mg PO q6h

Calcitrol

0.25 mg PO daily

Darbepoetin

60 mg SC qFriday

Folvite

1 mg PO daily

Meloxicam

7.5 mg PO daily

Ramipril

5 mg PO daily

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keep rest | reject rest [clear]

Acetaminophen

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Darbepoetin

60 mg SC qFriday

Ferrous Gluconate

300 mg PO TID

Folic acid

1 mg PO daily

Omeprazole

40 mg PO daily

Ramipril

5 mg PO daily

unique

unique

unique

unique

Twinlist

LIVE DEMO

spatial layout

to reveals similarities and differences

multi-step animation

to help 1st time users

carefully designed interaction

to facilitate task of reconciliation

Evaluation

- **1- Role of animation**

with students

- > **Animation helped users learn the layout**

- Fewer clarification questions

- Animated version preferred

- > Most said they would eventually turn off animation

- **2- Performance**

20 physicians

4 complex cases to reconcile

- 2 with Baseline

- 2 with Twinlist

~ SharpC at Maryland ~
User Interface and Visualization for Medication Reconciliation

MARYLAND PARTICIPANTS

- [Catherine Plaisant](#), (Co-PI) - Research Scientist, UMIACS, Associate Director of Research at HCIL
- [Ben Shneiderman](#), (Co-PI) - Professor, Computer Science, Researcher (and Founding Director) at HCIL
- (past) [Tiffany Chao](#), Graduate Student in the Department of Computer Science, University of Maryland
- [Johnny Wu](#), MS Graduate Student in the Department of Computer Science, University of Maryland

TEXAS AND KENTUCKY PARTNERS

- University of Texas, Houston: [Jorge Herskovic](#), [Elmer V Bernstam](#), [Eliz Markovitz](#) (and many more providing feedback)
- University of Kentucky: [Todd Johnson](#)
- Yale University: [Seth Powsner](#)
- Medstar Institute: [Zach Hettinger](#)

Medication Reconciliation

Two initial prototypes were completed to present two completely different user interface and ways for clinicians to address medication reconciliation (i.e. reconciling two lists of medications into a single reconciled list) in two different use-case scenarios. These interfaces (Twinlist and Medrec) were built on the substratum of a novel medication reconciliation algorithm that removes the tediousness of a fully manual reconciliation without diminishing the decision making power of the clinician.

Later on additional prototypes were developed with more complex cases, and alternative screen layout and grouping of the drugs. Current effort focus on evaluation with 2 controlled studies with physicians .

Papers

- **Latest description of Twinlist and several of its variations:**
[Plaisant, C., Chao, T., Wu, J., Hettinger, A., Herskovic, J., Johnson, T., Bernstam, E., Markowitz, E., Powsner, S., Shneiderman, B., Twinlist: Novel User Interface Designs for Medication Reconciliation, to appear in AMIA 2013 \(Tech report version\)](#)
- **Discussion of the role of animation in Twinlist and other similar interfaces:**
[Plaisant, C., Chao, T., Liu, R., Norman, K., Shneiderman, B. Multi-Step Animation to Facilitate the Understanding of Spatial Groupings: the Case of List Comparisons](#)
- **Early prototype description (Infovis class project):**
[Claudio, L., Khamis, S., Liu, R., London, B., Pujara, J., Plaisant, C., Shneiderman, B., Facilitating Medication Reconciliation with Animation and Spatial layout. Proceedings of the Workshop on Interactive Healthcare Systems \(WISH2011\)](#)
- **Early work:**
[Markowitz, E., Bernstam, E., Herskovic, J., Zhang, J., Shneiderman, B., Plaisant, C., Johnson, T., Medication Reconciliation: Work Domain Ontology, Prototype Development, and a Predictive Model \(AMIA Fall 2011\)](#)

Early papers:

- **Description of Twinlist - for potential implementers - January 2012 (newer version will follow soon):**
[Chao, T., Plaisant, C., Shneiderman, B., Twinlist: Overview and general implementation description](#)
- **Early Description of Twinlist:**
[Chao, T., Visual techniques for medication reconciliation: spatial metaphor, animated explanation, and flexible decision-making \(Undergrad Honor Project report - Dec 2011\)](#)

Videos

- **TWINLIST INTERFACE (visual layout and animation can help users see similarities in the lists):**
[Download the video of the latest version of Twinlist \(22.6 MB, 1024 x 768 resolution\)](#)



www.cs.umd.edu/hcil/sharp/twinlist (papers/videos)

Acknowledgements

Strategic Health IT Advanced Research Projects Program (SHARP)
 Office of the National Coordinator for Health Information Technology (Grant Number 10510592)



Thank You

UI design can have strong impact on patient safety

Numerous ways to reveal similarity

Multi-step animations can help 1st time users

Consider grouping

Twinlist open source (email me)

plaisant@cs.umd.edu

www.cs.umd.edu/hcil/sharp/twinlist (papers/videos)



Acknowledgements

Strategic Health IT Advanced Research Projects Program (SHARP)

Office of the National Coordinator for Health Information Technology (Grant Number 10510592)

