Webinar

sesstim.univ-amu.fr & openhealth-institute.org

Catherine PLAISANT

PhD University of Maryland, USA

Analyse visuelle de patterns temporels dans les données des patients

avril 2018

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UNIVERSITY OF MARYLAND

Analyse Visuelle de Patterns Temporels dans les Données Patient

Catherine Plaisant

HCIL

plaisant@cs.umd.edu

Webinaire Marseille ~ April 6, 2018

Human-Computer Interaction Lab

Interdisciplinary Research Community

Computer Science
Information Studies
Psychology, Engineering, Business, Education, etc.

www.cs.umd.edu/hcil

Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th Edition

Ben Shneiderman, University of Maryland
Catherine Plaisant, University of Maryland
Maxine Cohen, Nova Southeastern University
Steven Jacobs, Northern Arizona University
Niklas Elmqvist, University of Maryland
Nicholas Diakopoulos, University of Maryland

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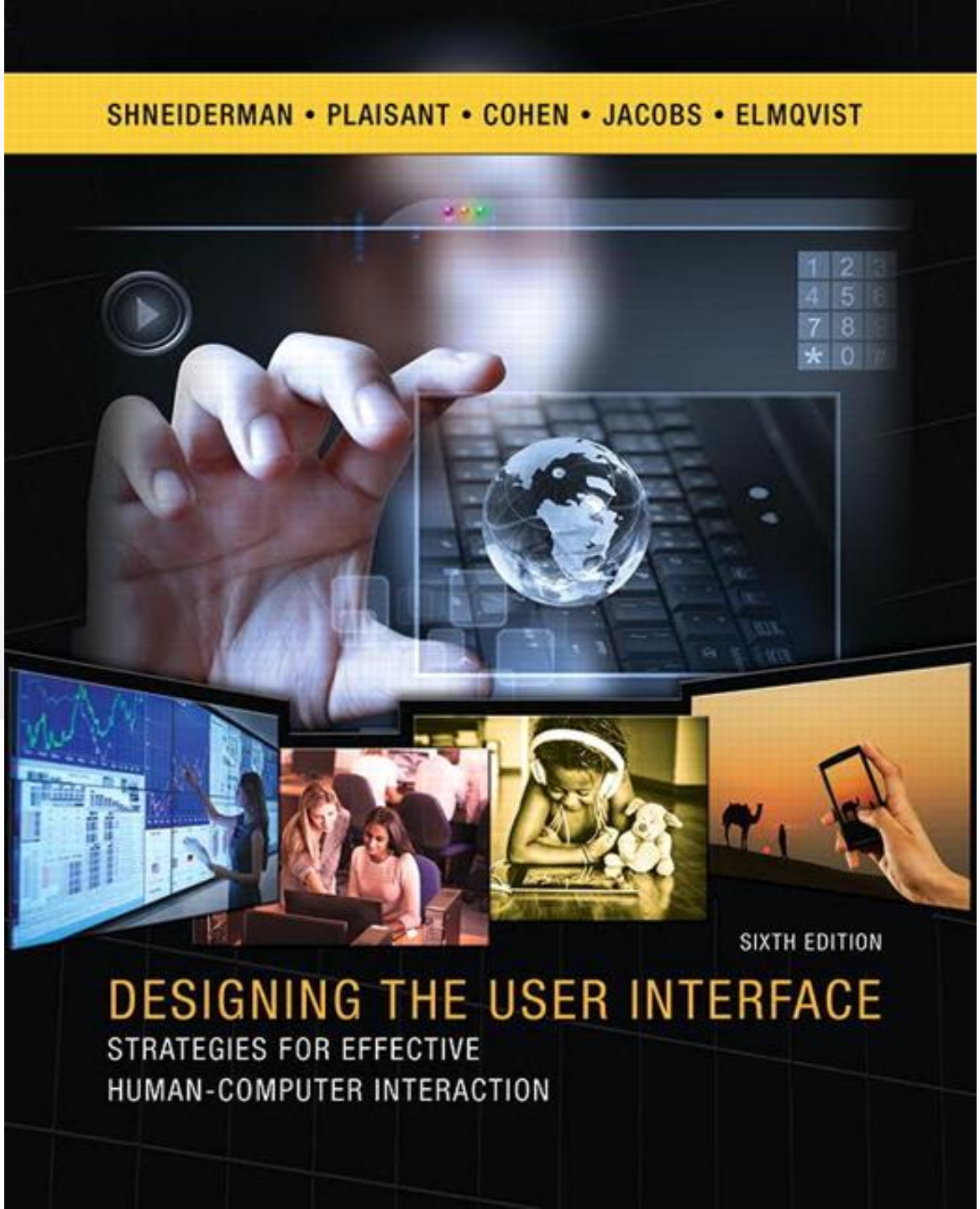
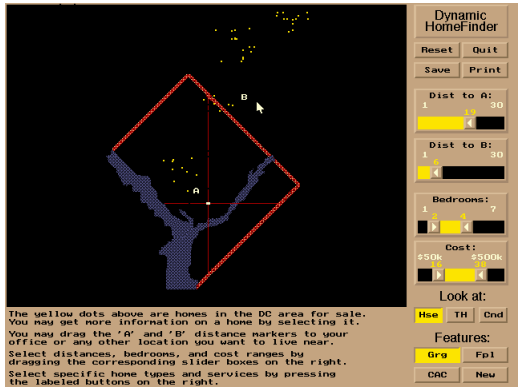
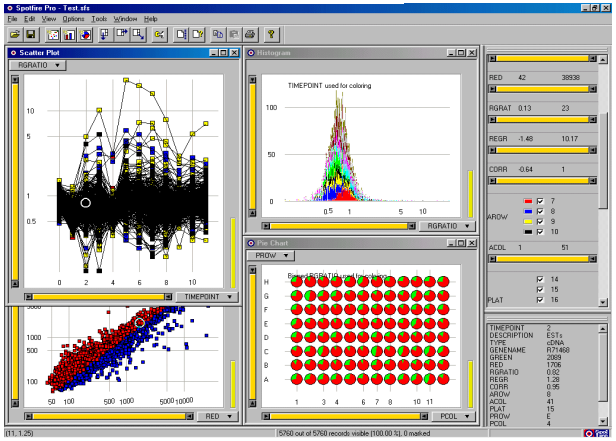


Information visualization

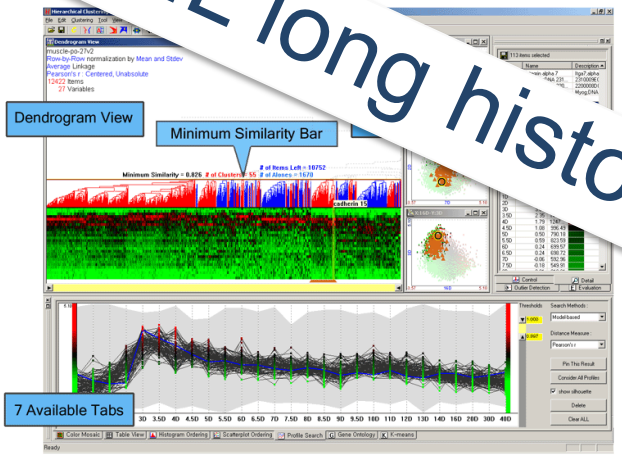


TIBCO Spotfire

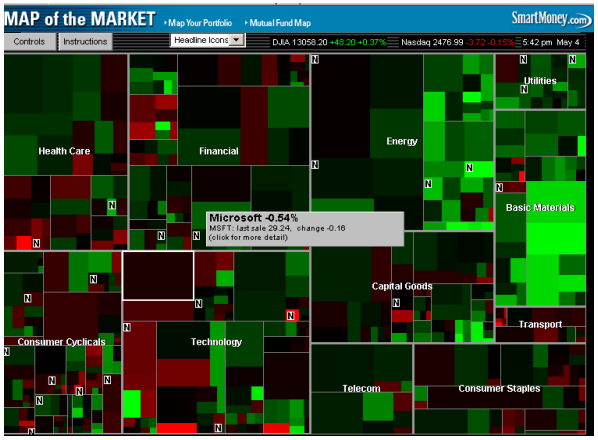


Home Finder and Filmfinder prototypes lead to SpotFire

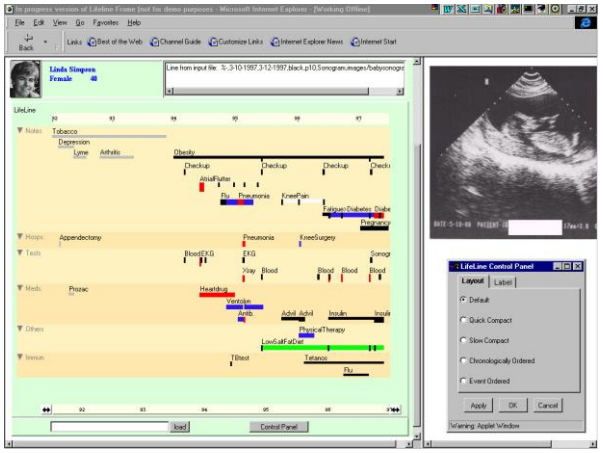
HCIL long history



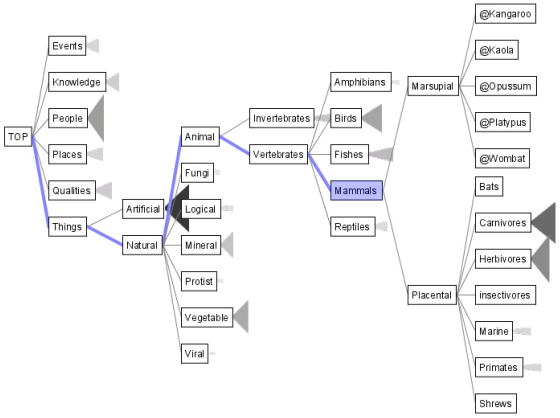
Hierarchical Clustering Explorer HCE



Treemap



Lifelines



SpaceTree

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

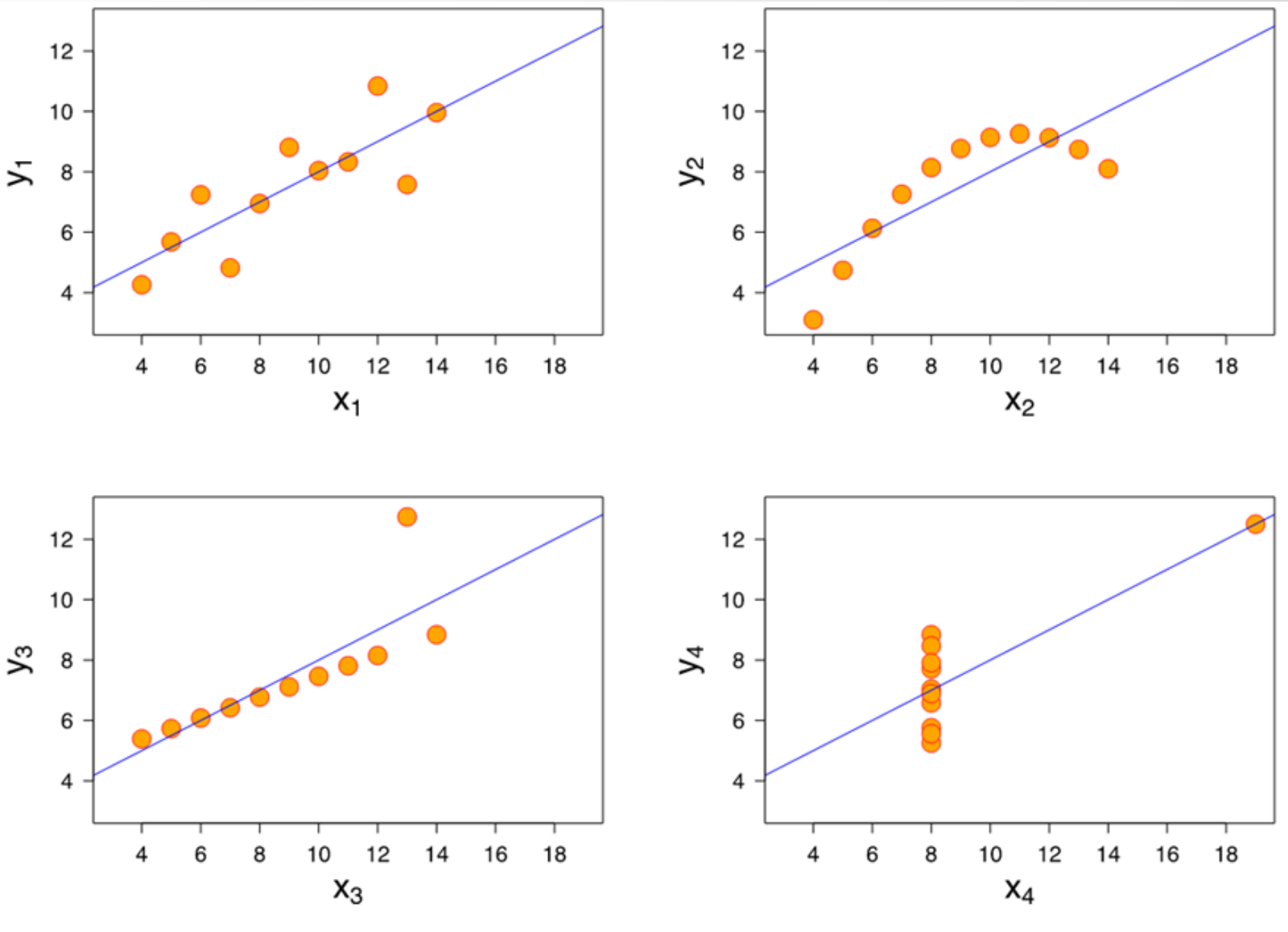
ANSCOMBE'S QUARTET

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

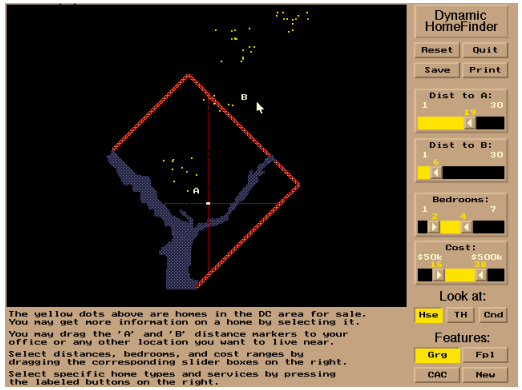
Compact graphical presentation and user interface

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

Information visualization



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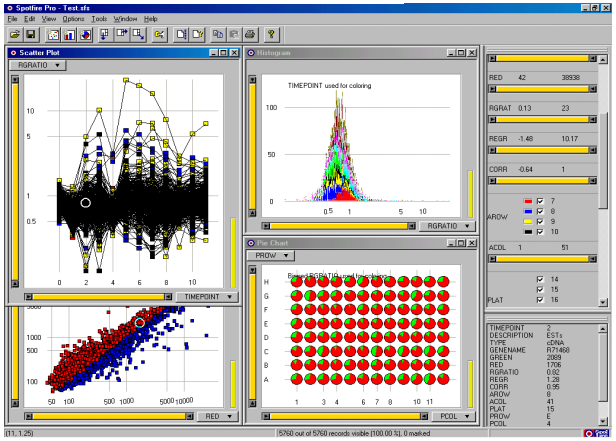

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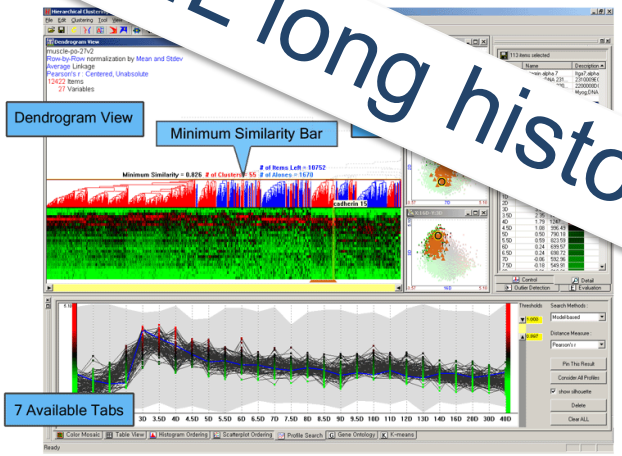

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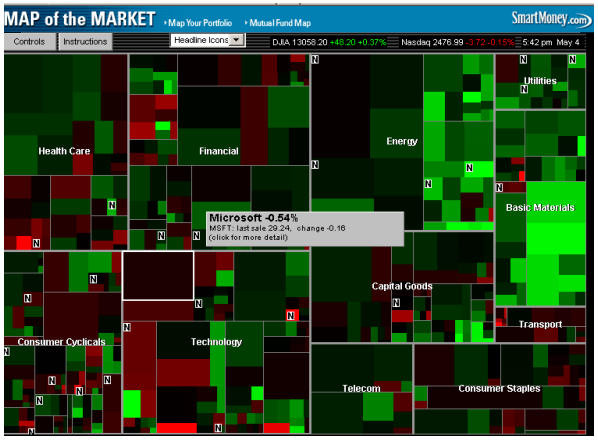
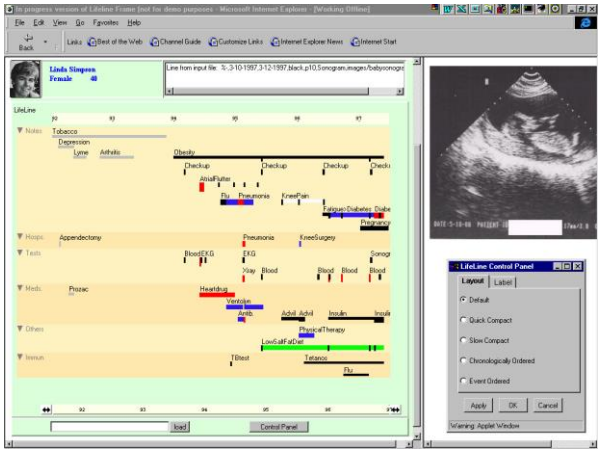
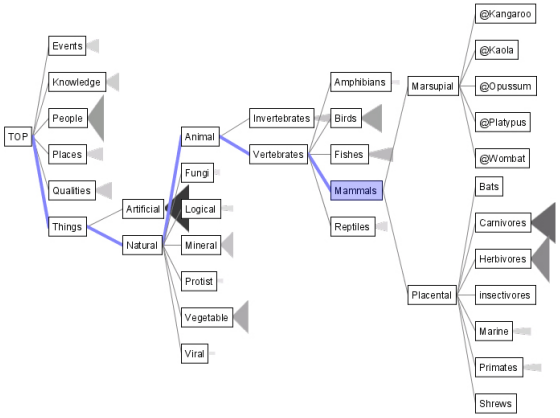


Treemap



Lifelines



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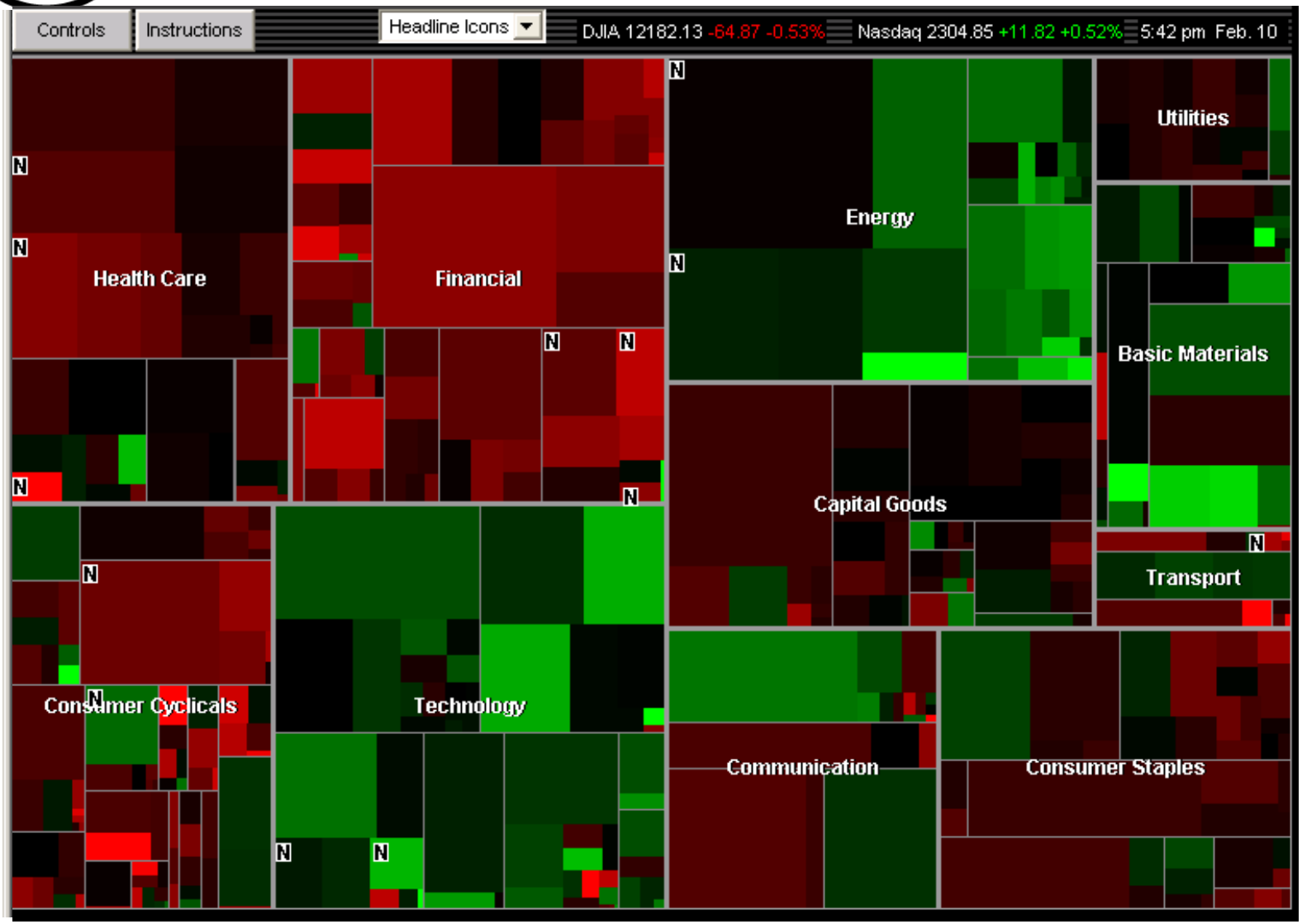
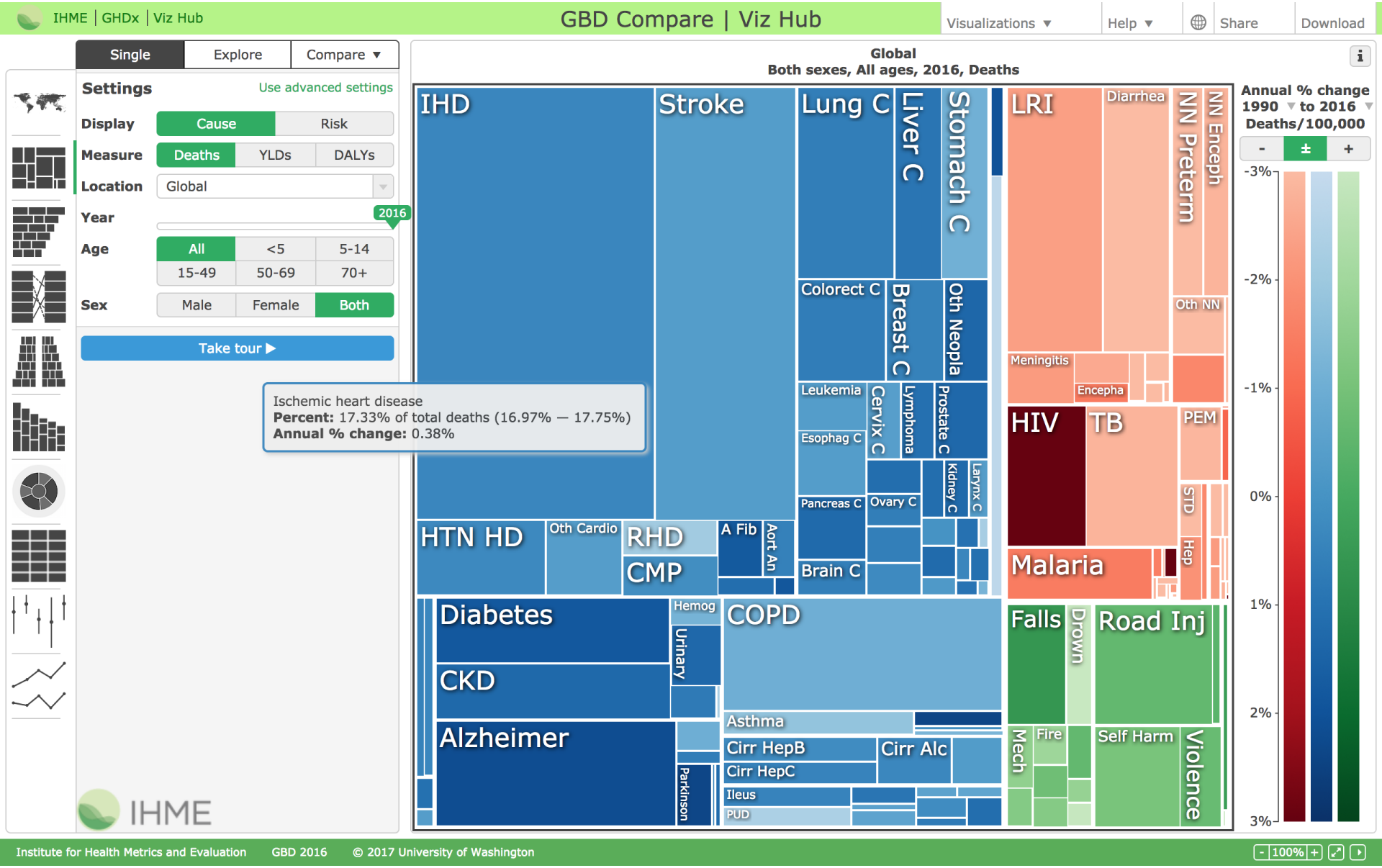
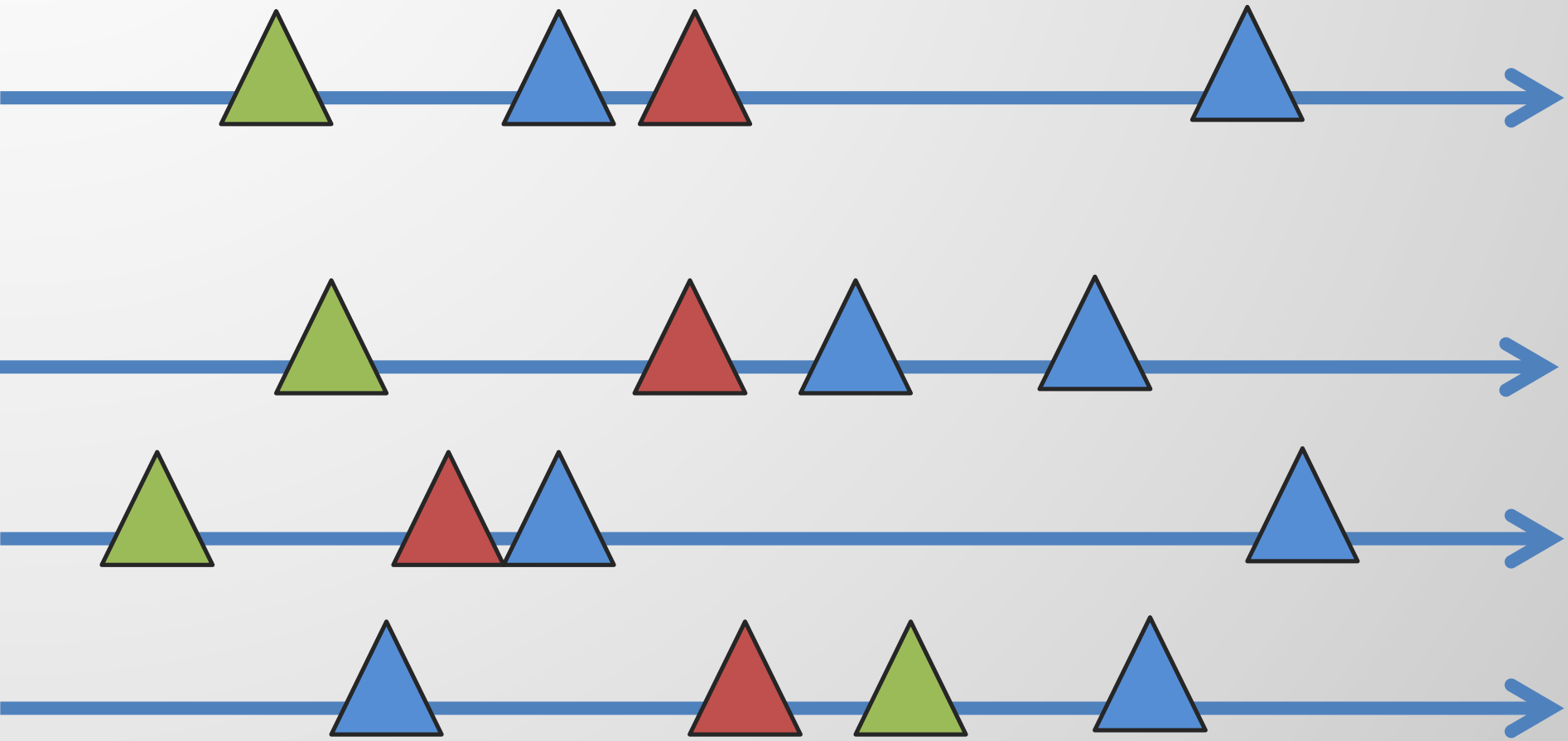


See commercial example online at: https://finviz.com/map.ashx?t=sec



U of Washington - https://vizhub.healthdata.org/gbd-compare/

Event Analytics

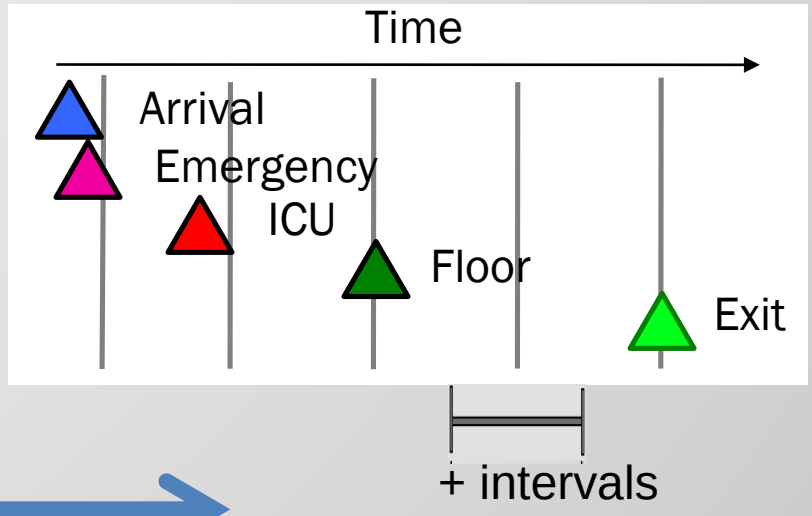


Numerical

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

Many application domains

Electronic Health Records: symptoms, treatment, lab test

Student records: course, paper, proposal, defense, etc.

Web logs, usability logs, security etc.

Traffic incident logs: confirmed, unit arrived, lane closed etc.

HCIL Prototype evolution

Tool	Event Types	Records	Display
LifeLines	Points, Intervals	One	Individual
LifeLines2	Points	Many	Individual, Summary
Similan	Points	Many	Individual
LifeFlow	Points	Many	Individual, Aggregate
EventFlow	Points, Intervals	Many	Individual, Aggregate

ORACLE

Adobe

Children's National

MedStar Washington Hospital Center

NIH National Institutes of Health

University of Maryland School of Pharmacy

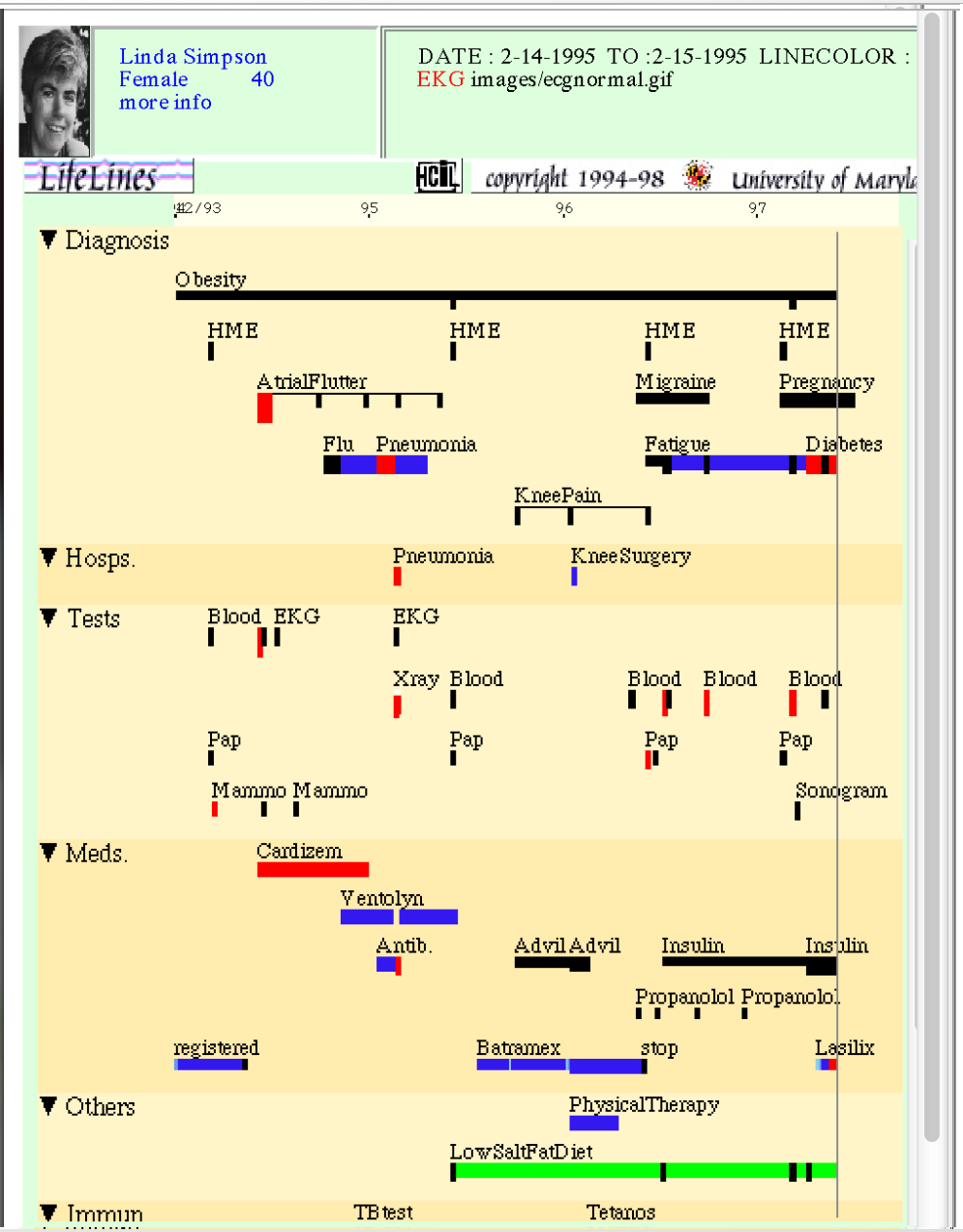
UF University of Florida

Yale University School of Medicine

UBC The University of British Columbia

CDC Centers for Disease Control and Prevention

www.cs.umd.edu/hcil/*toolname*



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

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: %-,2-14-1995,2-14-1995,severe,p12, ,images/pneumonia.gif,"nid"

LifeLine

9/94 10/94 11/94 12/94 1/95 2/95 3/95 4/95 5/95

Notes
- Obesity
- Heart*
- Flu
- Bronchitis
- Pneumonia
- Pneumonia

Hosps.
- Pneumonia

Tests
- EKG
- Xray

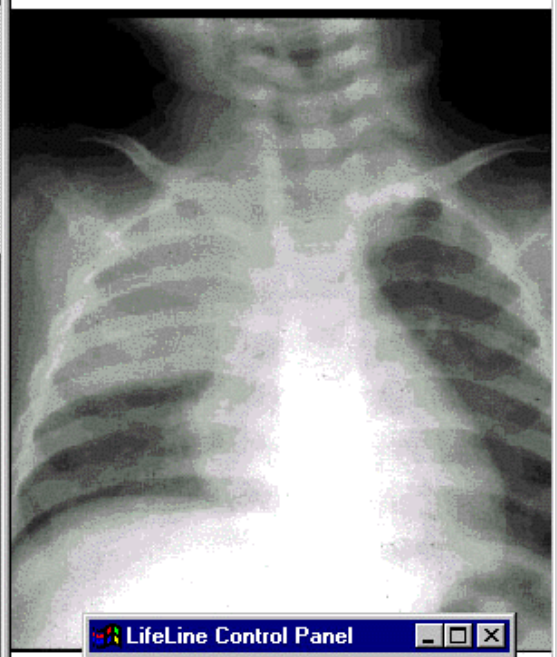
Meds.
- Heartdrug
- Ventolyn
- Antib.
- Ventolyn
- Antib.

Others

Immun.
- TBtest

92 93 94 95 96 97

load Control Panel



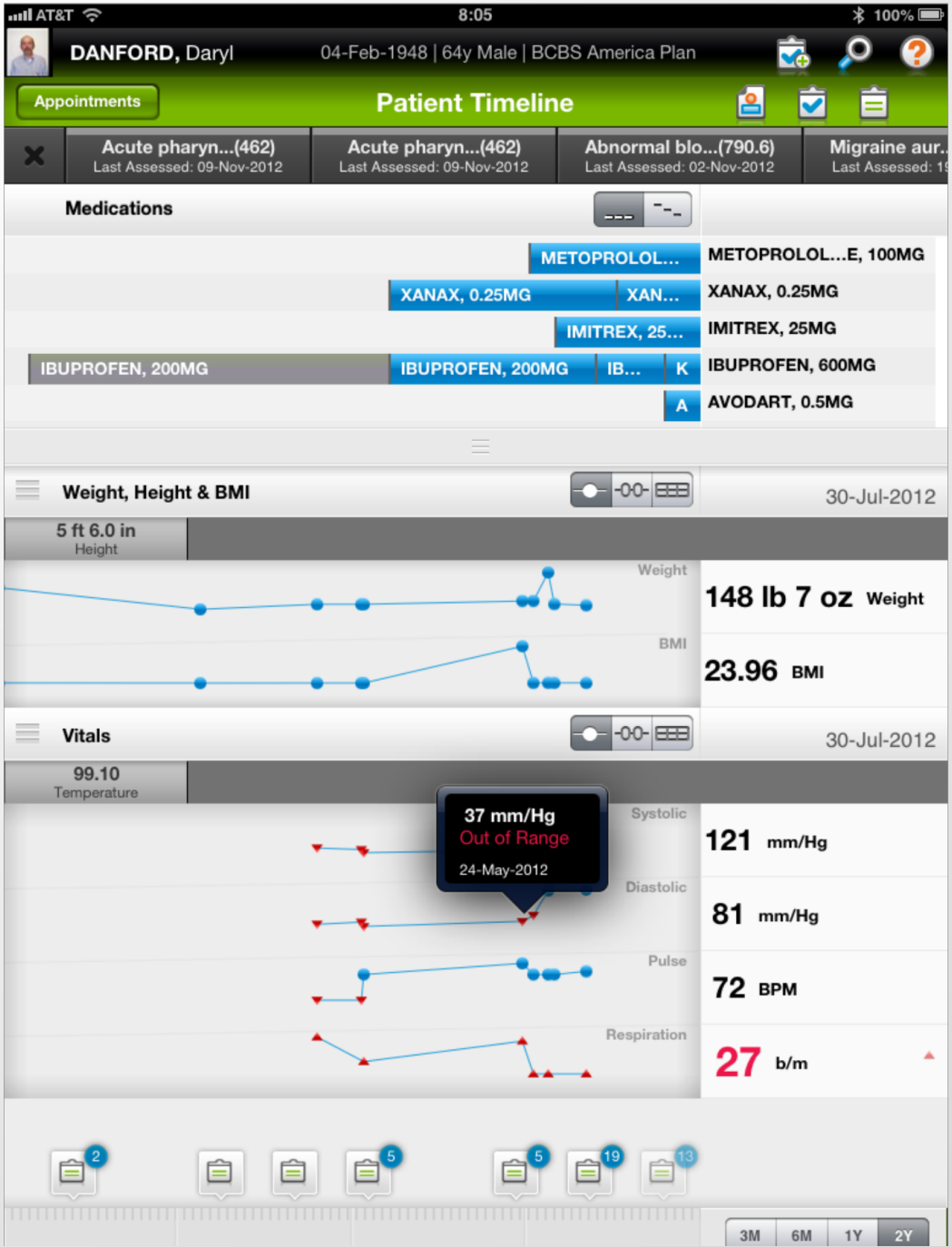
LifeLine Control Panel

Layout Label

- (•) Default
- ( ) Quick Compact
- ( ) Slow Compact
- ( ) Chronologically Ordered
- ( ) Event Ordered

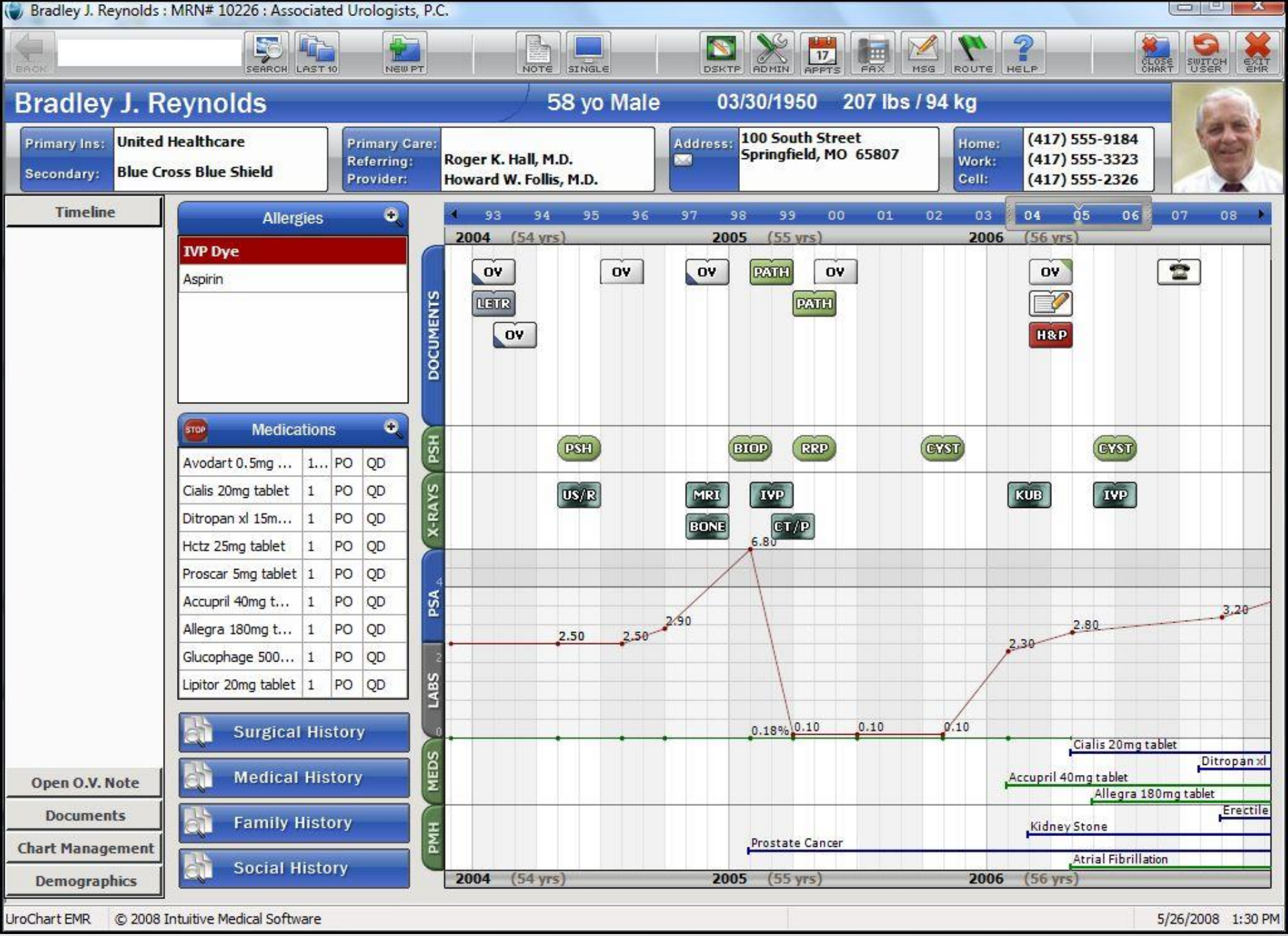
Apply OK Cancel

Warning: Applet Window



The Wand Timeline view of a patient record in Allscript's ambulatory EHR iPad application.

Used with permission of Allscripts.



http://www.healthtronics.com/physicians/it-solutions/urochartehr-system-product-overview

A SINGLE RECORD

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

MANY RECORDS

RECORD

RECORD

RECORD

RECORD

RECORD

Are we following guidelines?

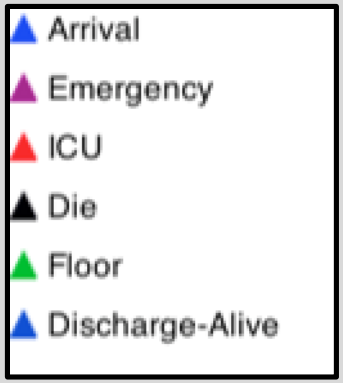
Find patients with Y and Z for my trial

How are opioids prescribed?

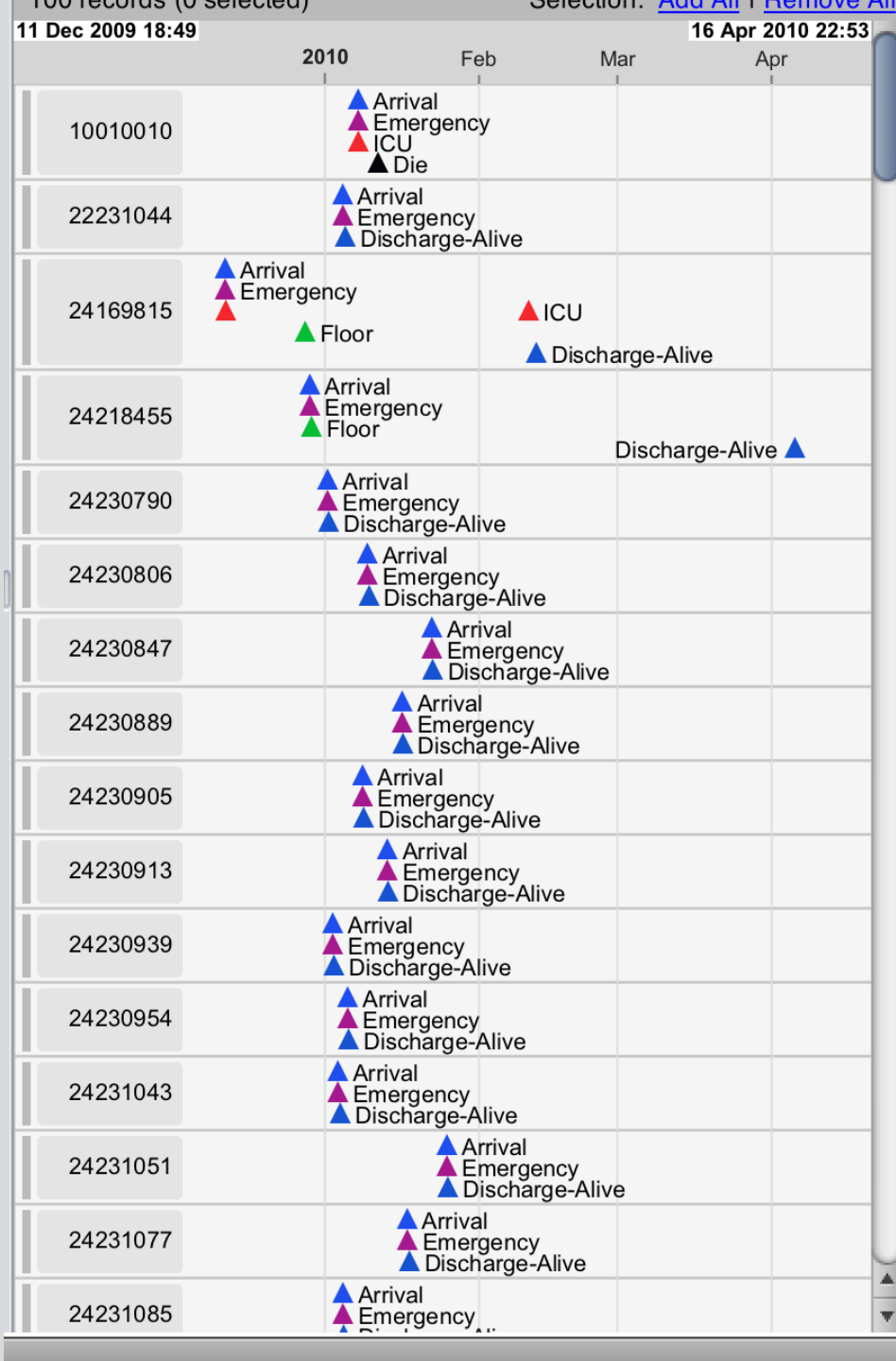
Can we improve this workflow?

Example:
Where do patients go after they leave the emergency room?

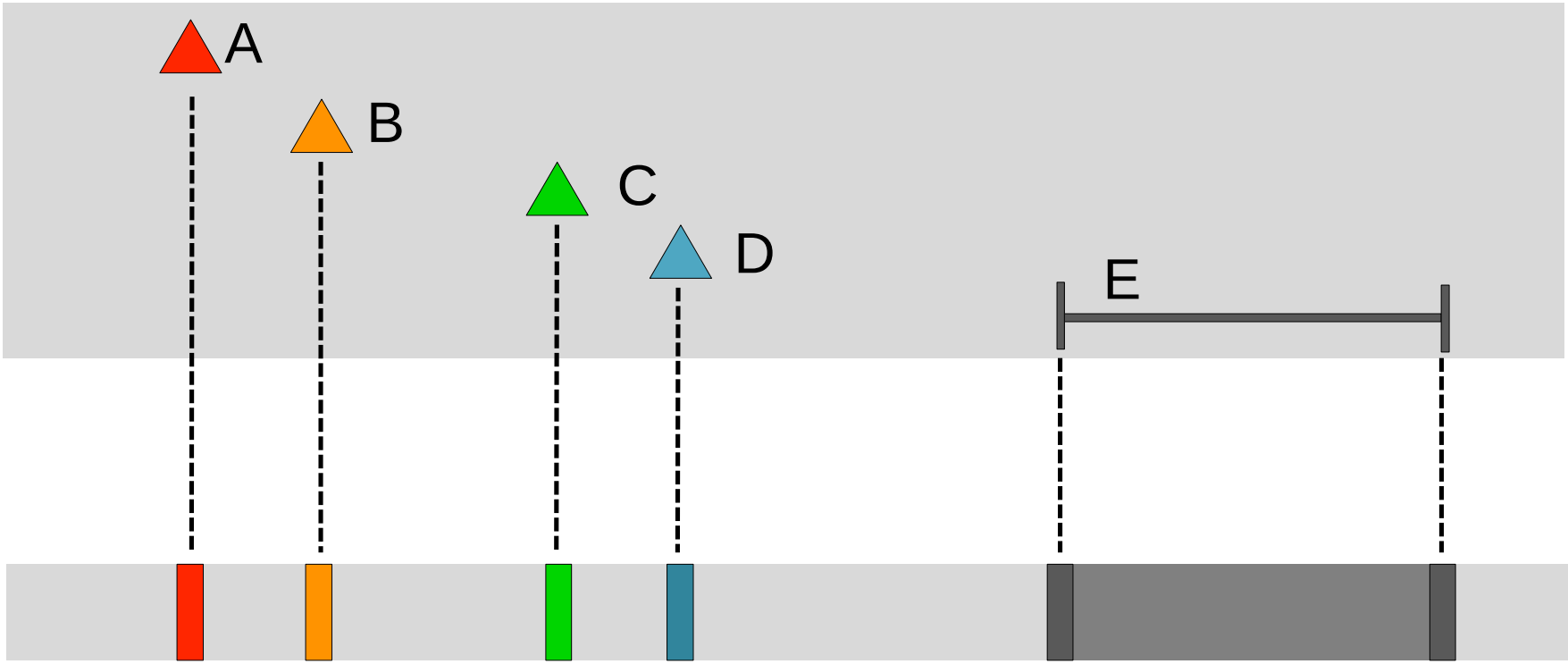
Data: Transfers within Hospital

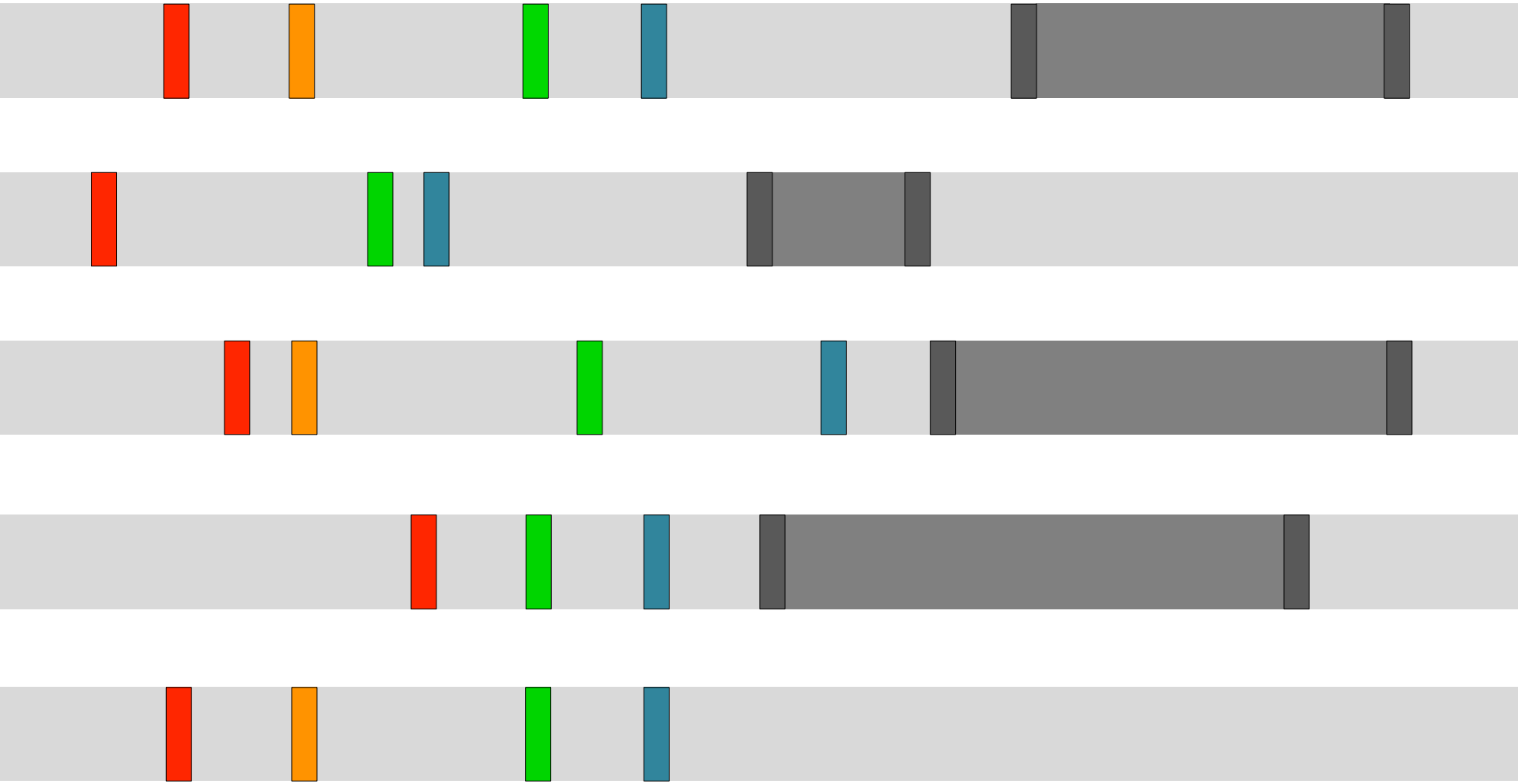


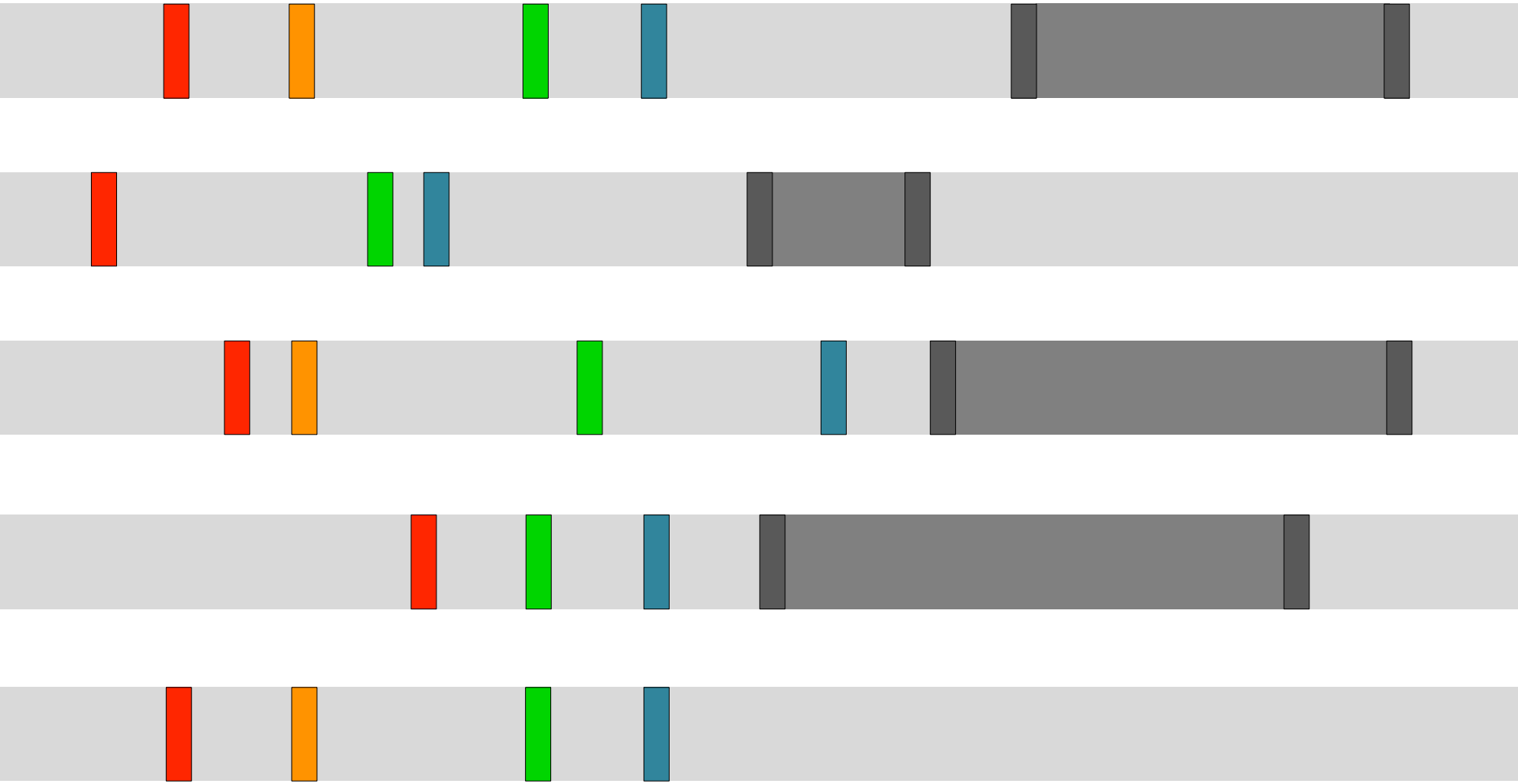
Summarize all the sequences

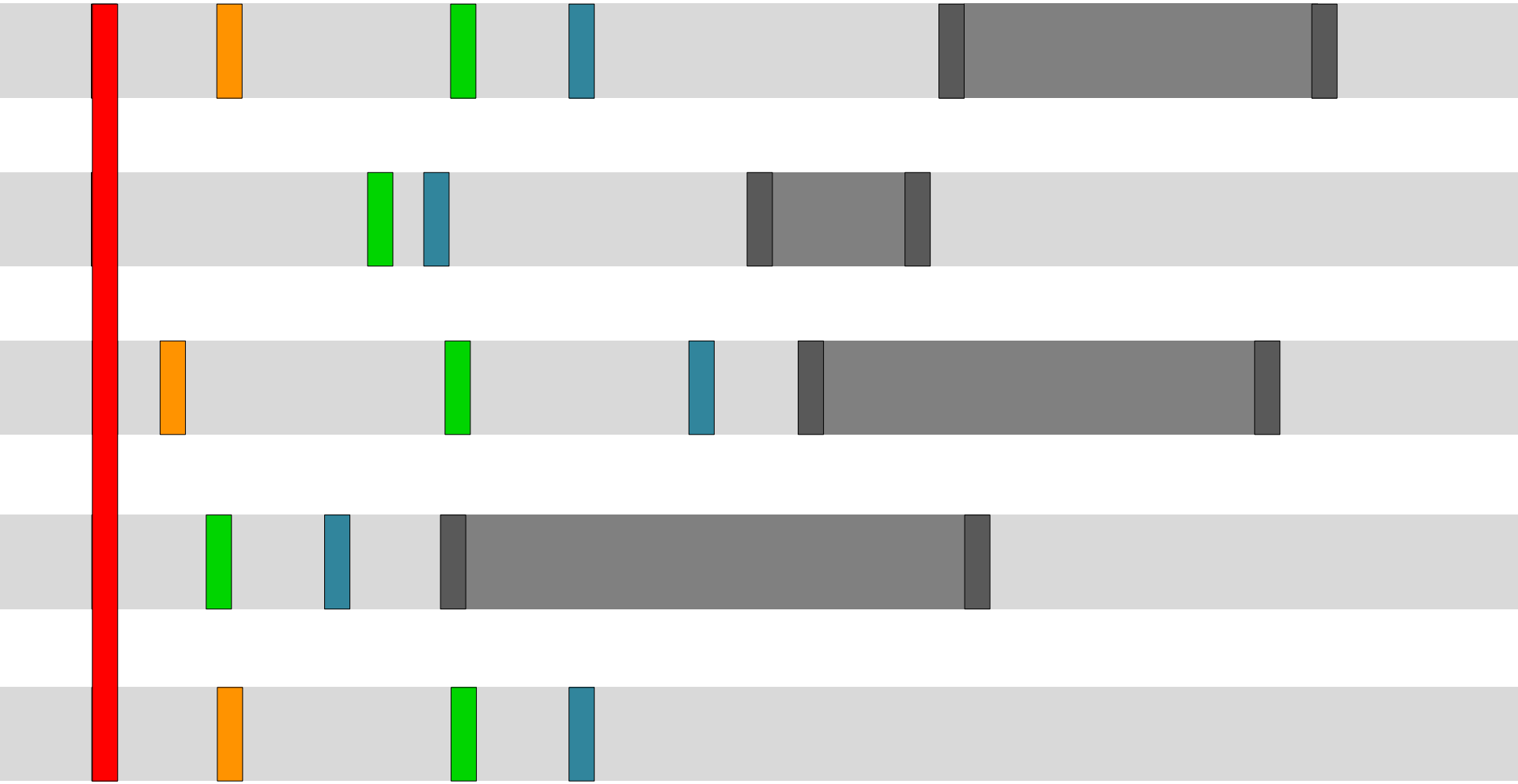


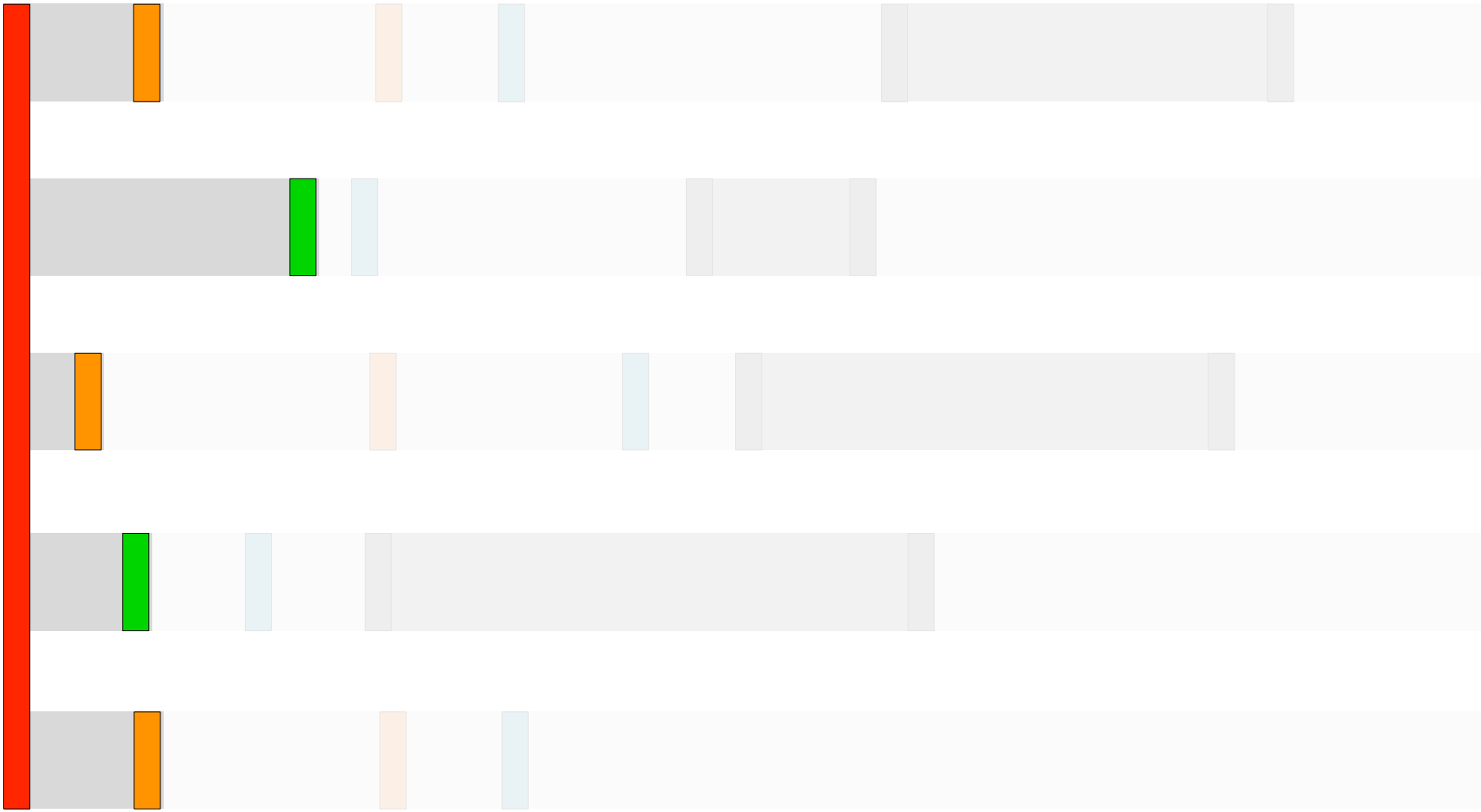
Constructing the EventFlow Overview

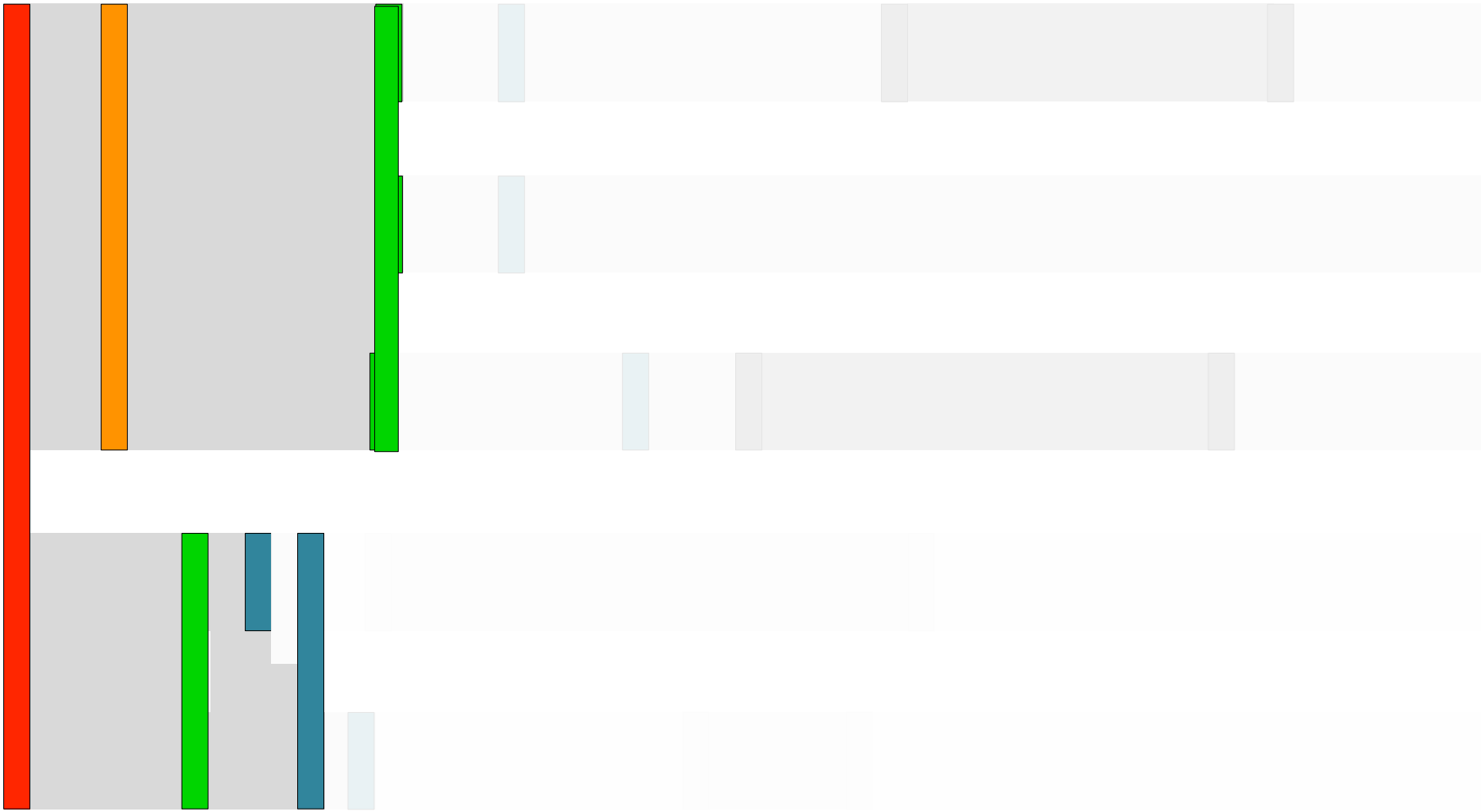


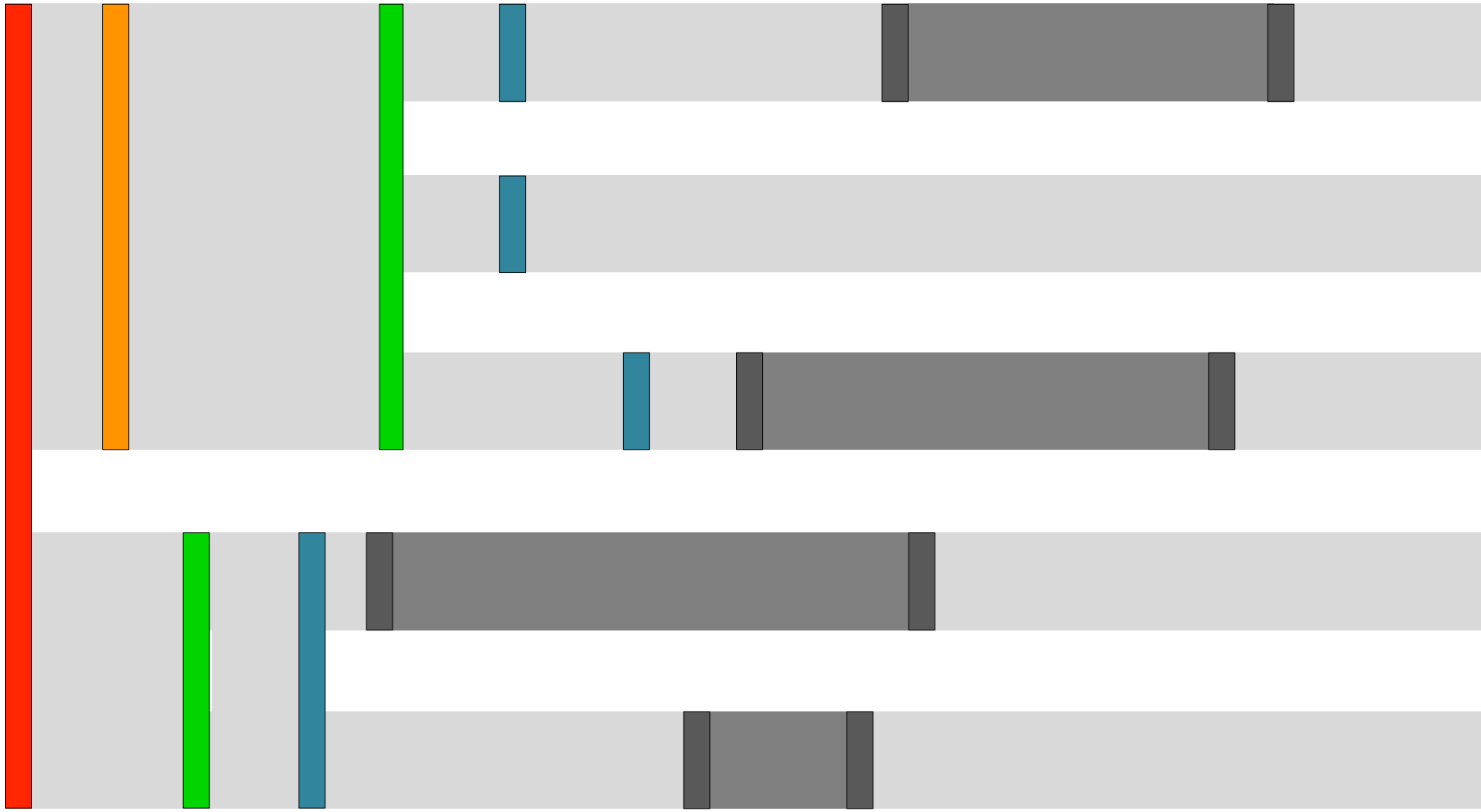


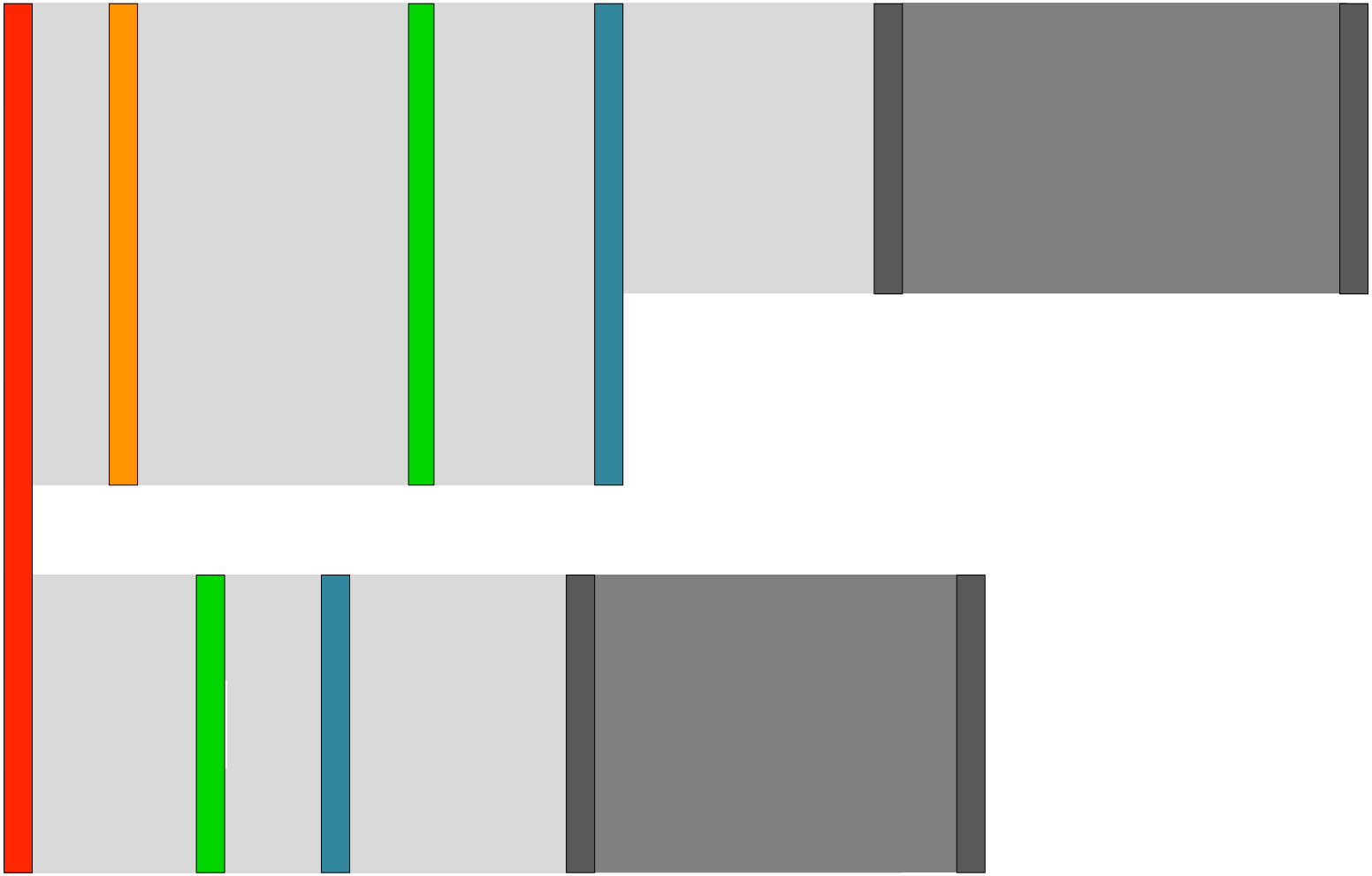


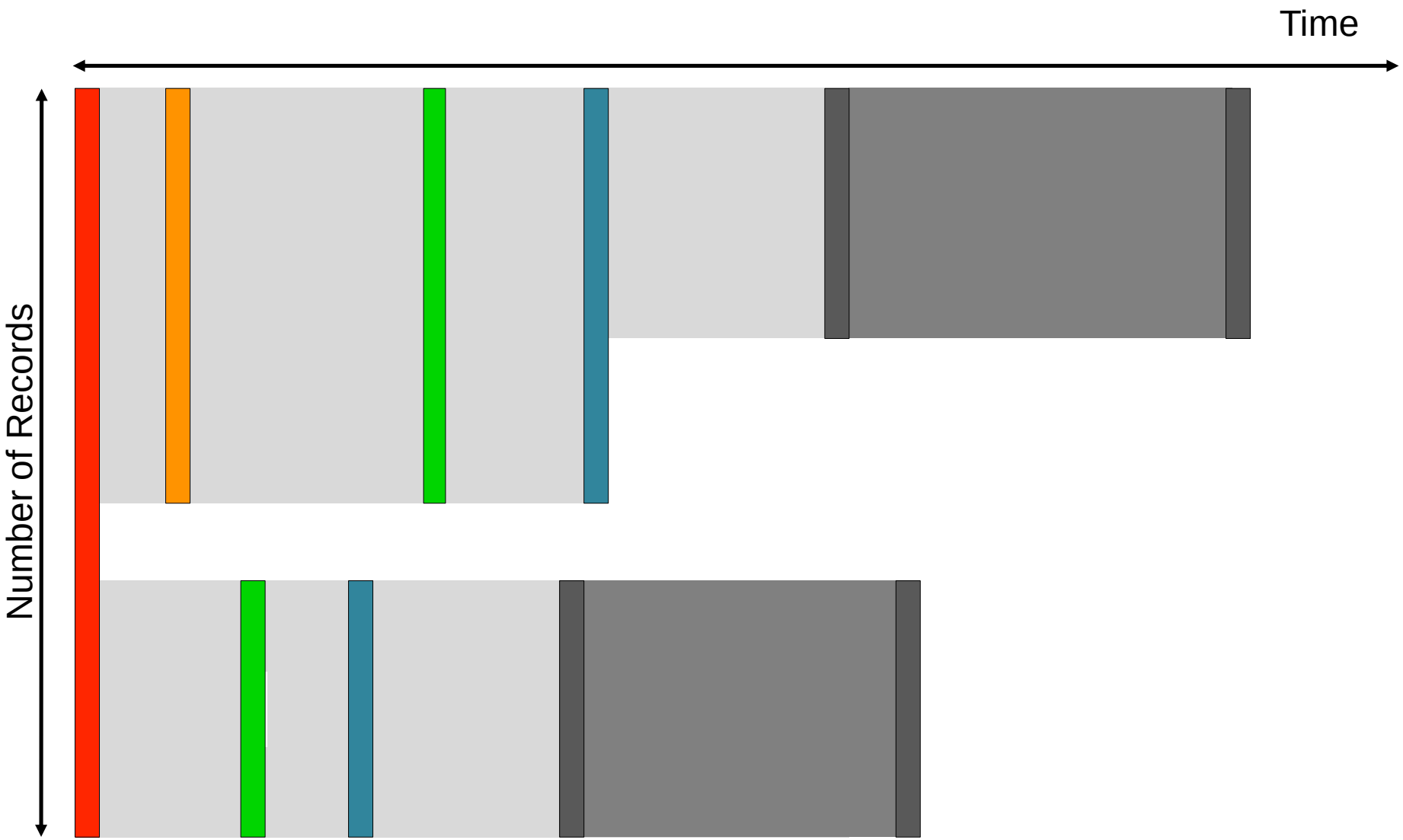




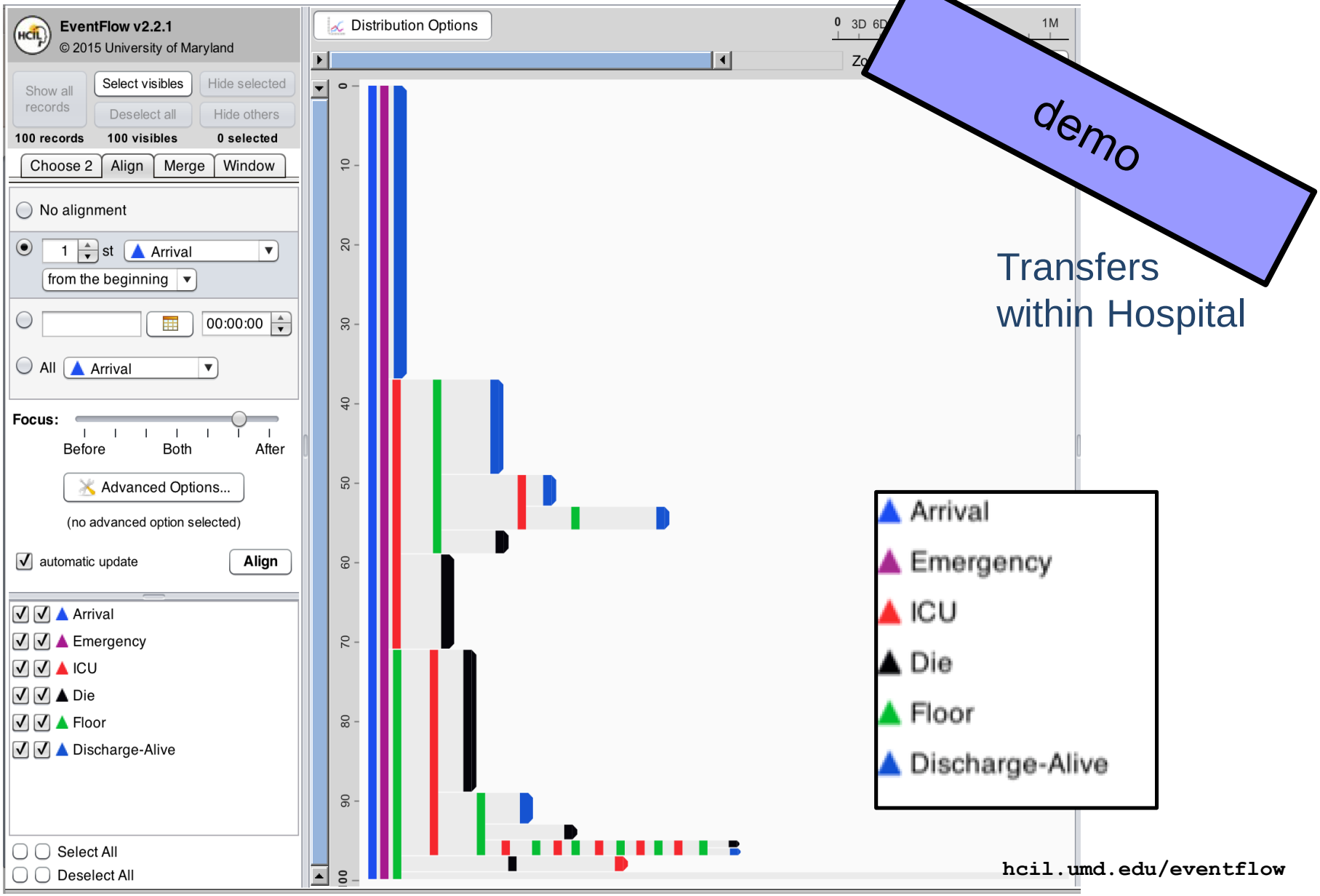


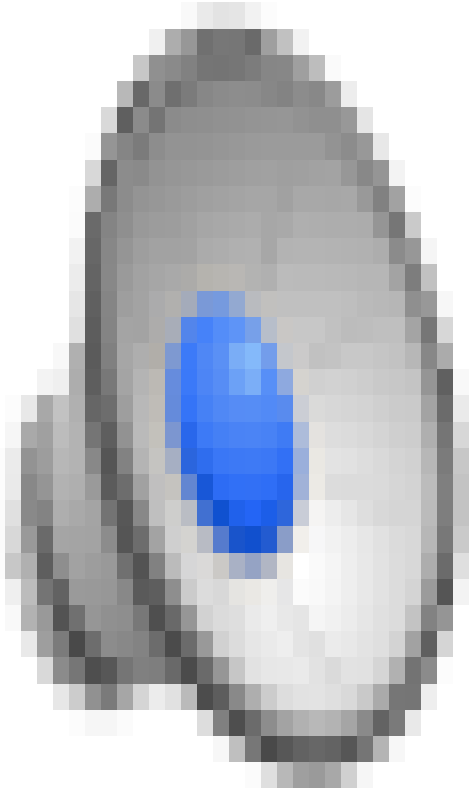





Time
Number of Records

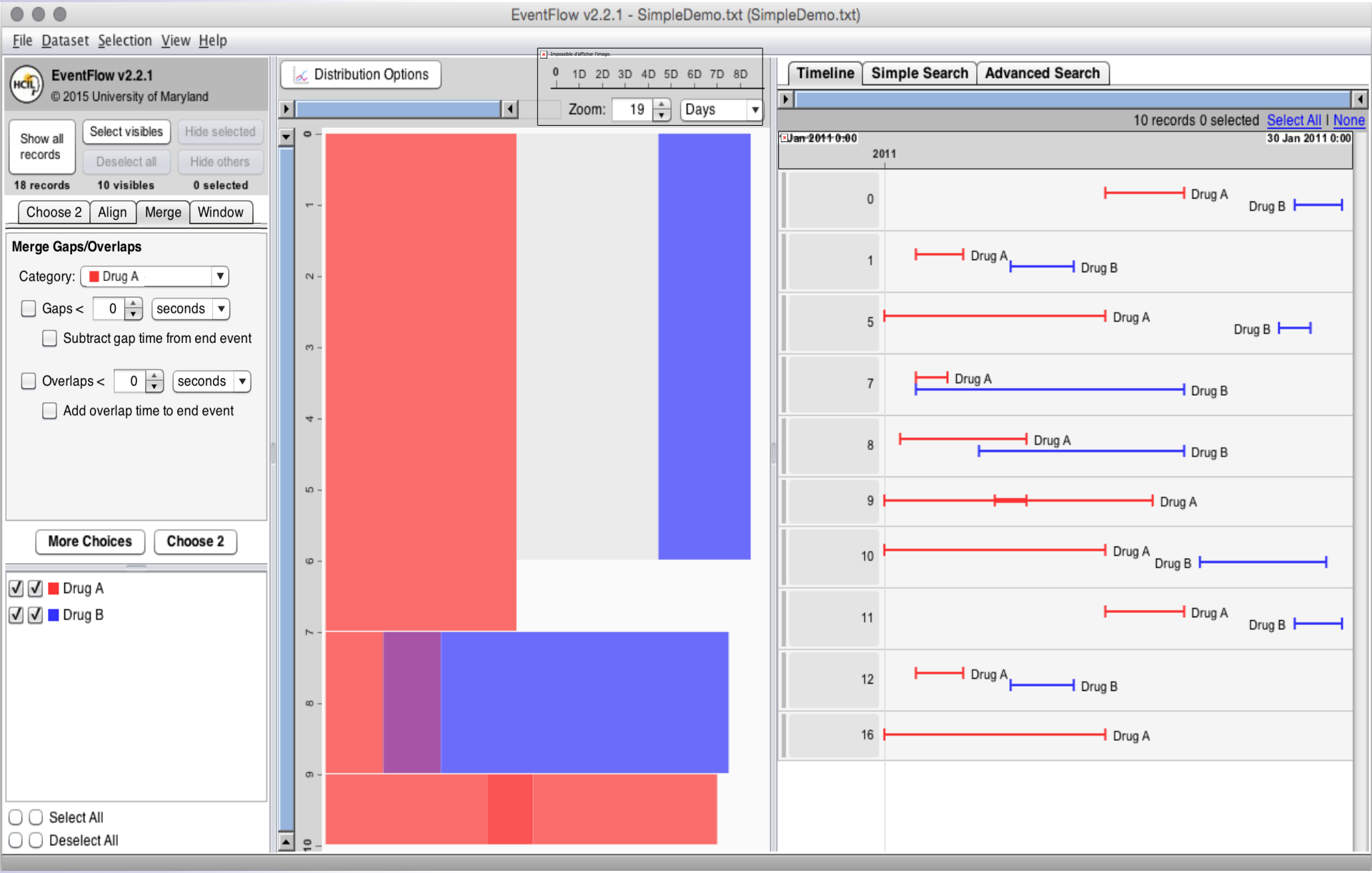
Eventflow: overview of all sequences

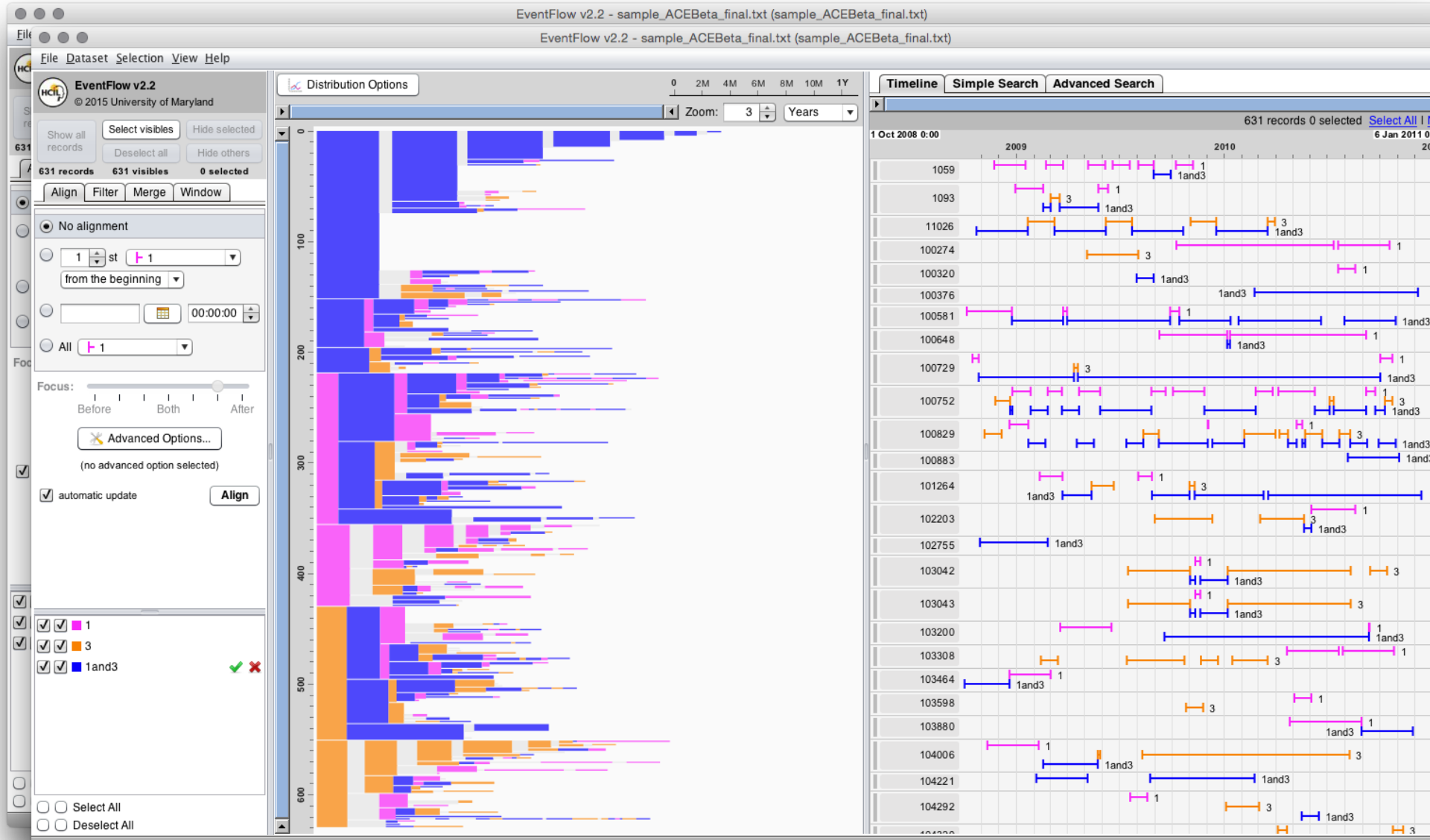




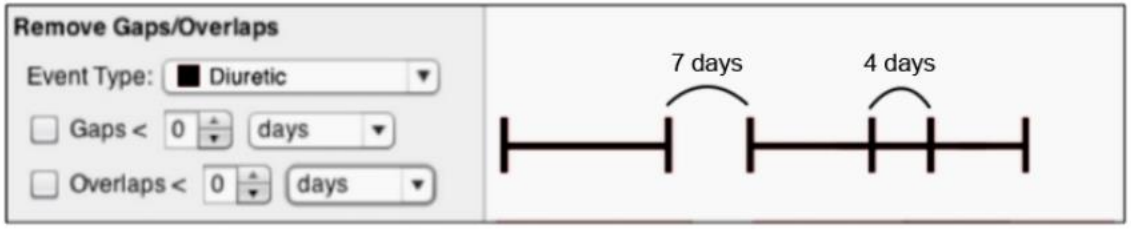
Lien vers la vidéo : EventFlow short demo

https://www.youtube.com/watch?v=ZN1BefRmBMc

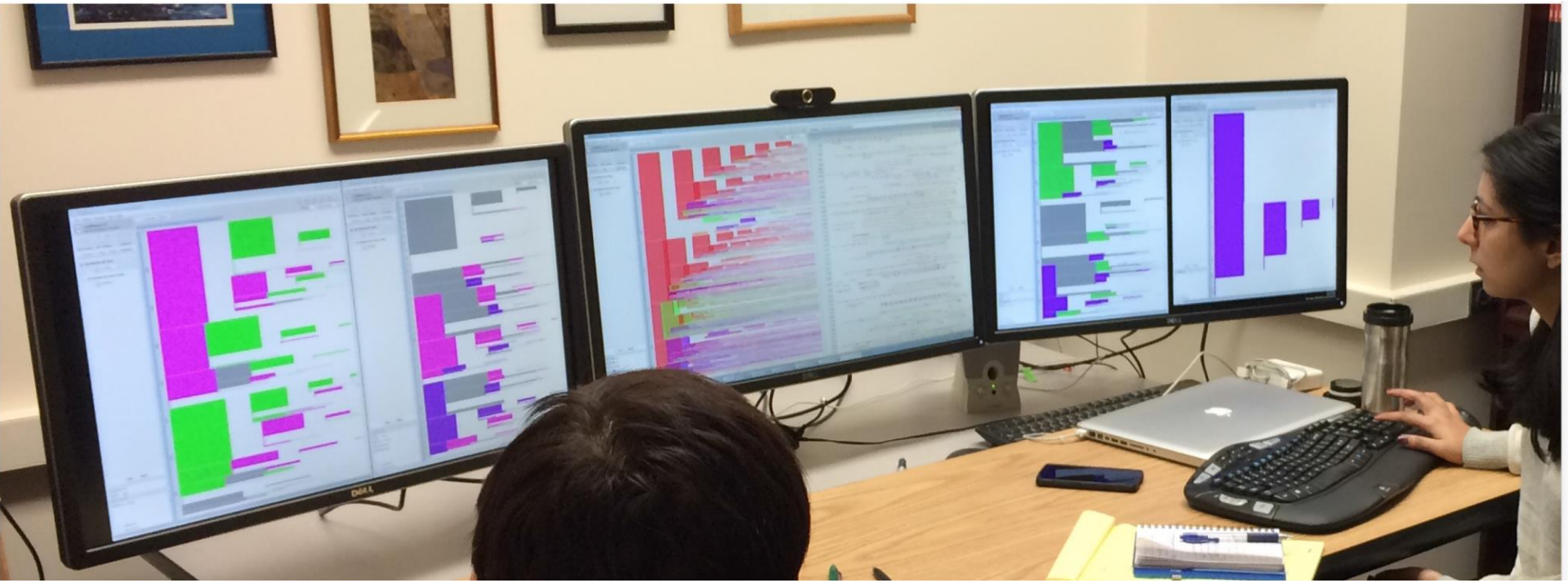

EventFlow v2.2.1 - SimpleDemo.txt (SimpleDemo.txt)
File Dataset Selection View Help
EventFlow v2.2.1
© 2015 University of Maryland
Show all records
Select visibles
Hide selected
Deselect all
Hide others
18 records
10 visibles
0 selected
Choose 2
Align
Merge
Window
Merge Gaps/Overlaps
Category: Drug A
Gaps < 0 seconds
Subtract gap time from end event
Overlaps < 0 seconds
Add overlap time to end event
More Choices
Choose 2
Drug A
Drug B
Select All
Deselect All
Distribution Options
0 1D 2D 3D 4D 5D 6D 7D 8D
Zoom: 19 Days
Timeline
Simple Search
Advanced Search
10 records 0 selected Select All | None
30 Jan 2011 0:00
2011
0
1
5
7
8
9
10
11
12
16
Drug A
Drug B


EventFlow v2.2 - sample_ACEBeta_final.txt (sample_ACEBeta_final.txt)
EventFlow v2.2 - sample_ACEBeta_final.txt (sample_ACEBeta_final.txt)
File Dataset Selection View Help
EventFlow v2.2
© 2015 University of Maryland
Show all records
Select visibles
Hide selected
Deselect all
Hide others
631 records
631 visibles
0 selected
Align
Filter
Merge
Window
No alignment
1 st 1
from the beginning
00:00:00
All 1
Focus:
Before
Both
After
Advanced Options...
(no advanced option selected)
automatic update
Align
1
3
1and3
Select All
Deselect All
Distribution Options
0 2M 4M 6M 8M 10M 1Y
Zoom: 3 Years
0
100
200
300
400
500
600
Timeline
Simple Search
Advanced Search
631 records 0 selected Select All
1 Oct 2008 0:00
6 Jan 2011 0
2009
2010
1059
1093
11026
100274
100320
100376
100581
100648
100729
100752
100829
100883
101264
102203
102755
103042
103043
103200
103308
103464
103598
103880
104006
104221
104292

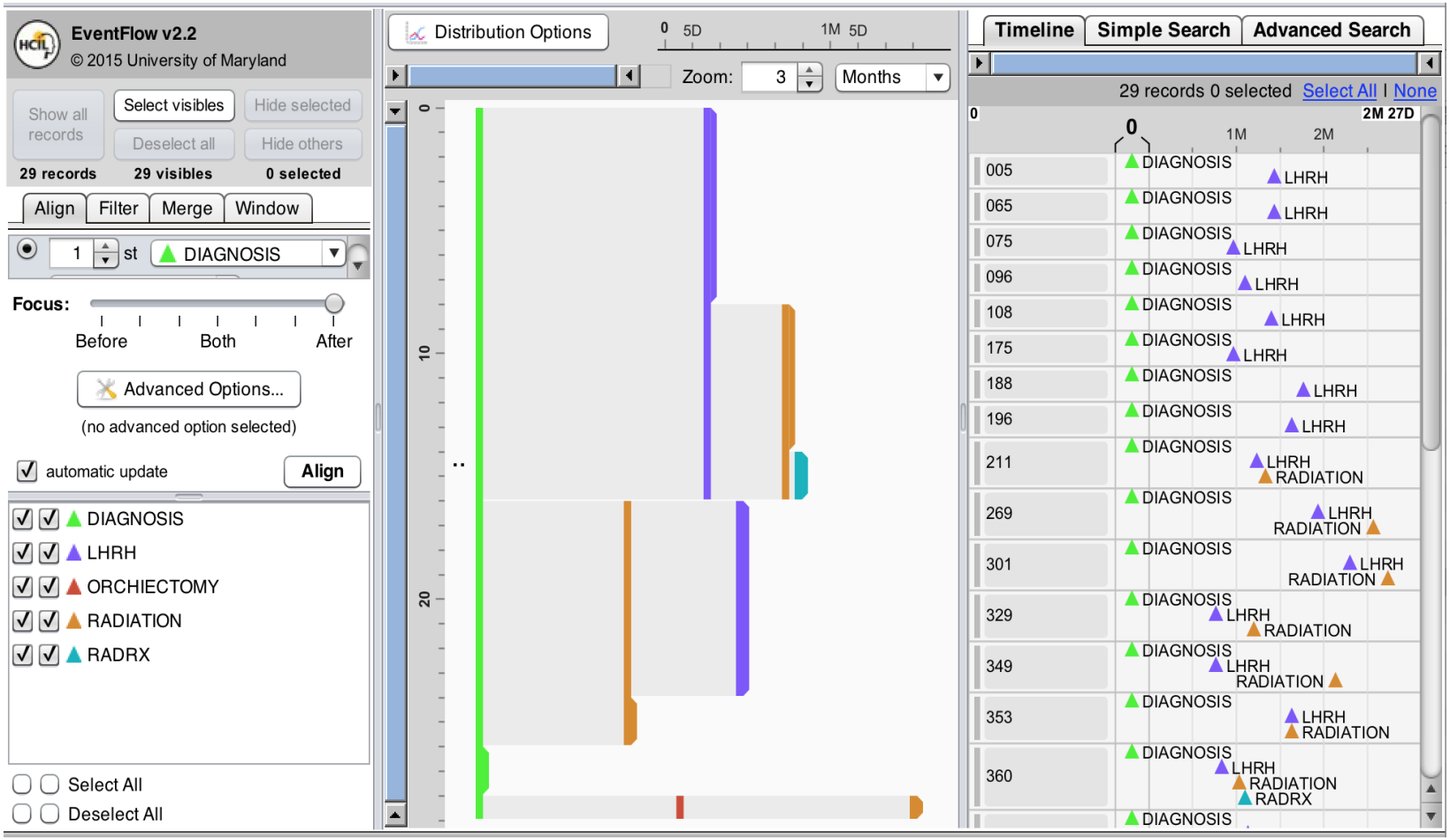
Interactively manage gaps and overlaps



Understanding Adherence Using Large Scale Claims Data

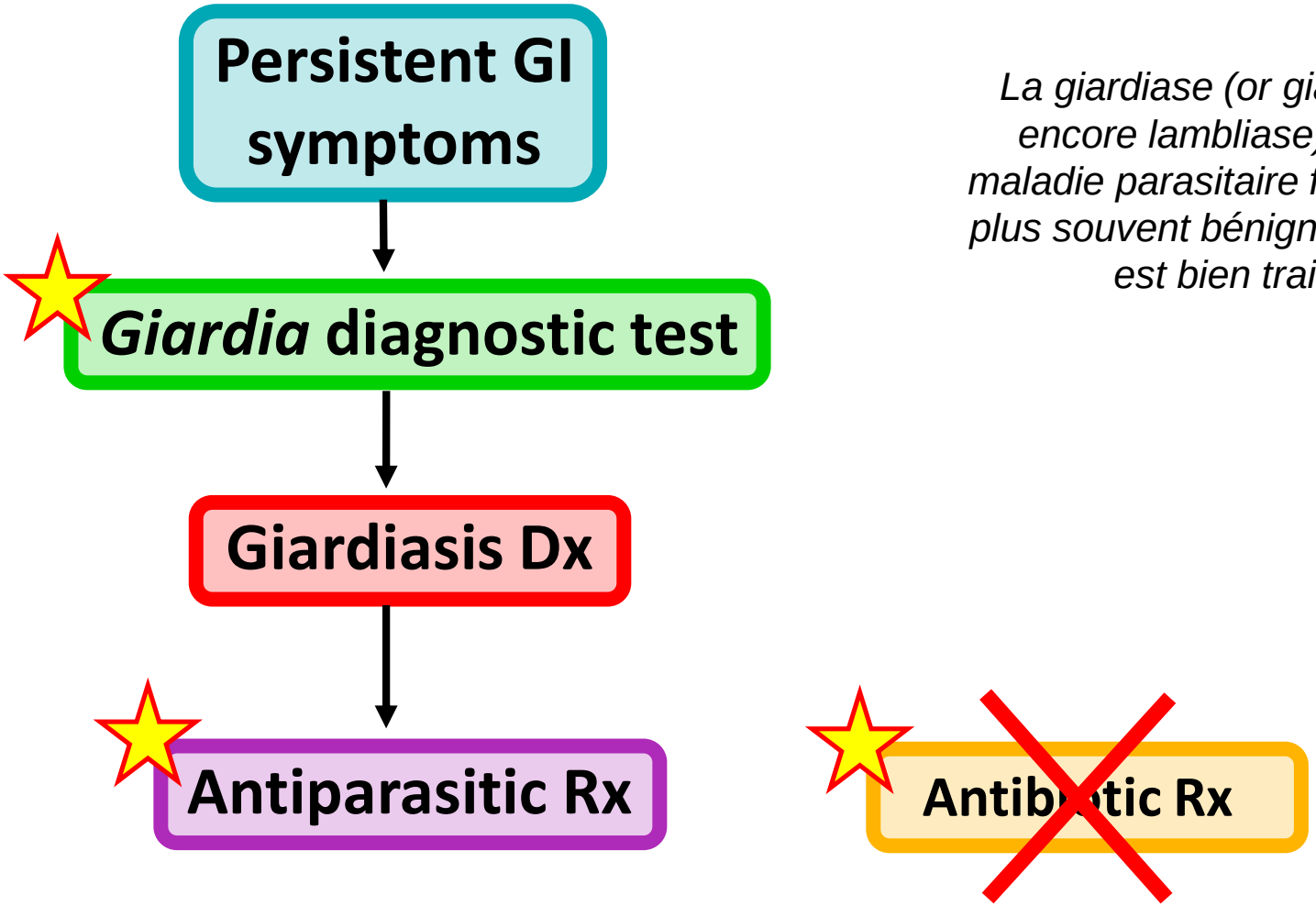


Bjarnadottir, M., Malik, S., Onukwugha, E., Gooden, T., Plaisant, C.
Understanding Adherence and Prescription Patterns Using Large Scale Claims Data
PharmacoEconomics, Volume 34, Issue 2, pp 169-179, 2016.



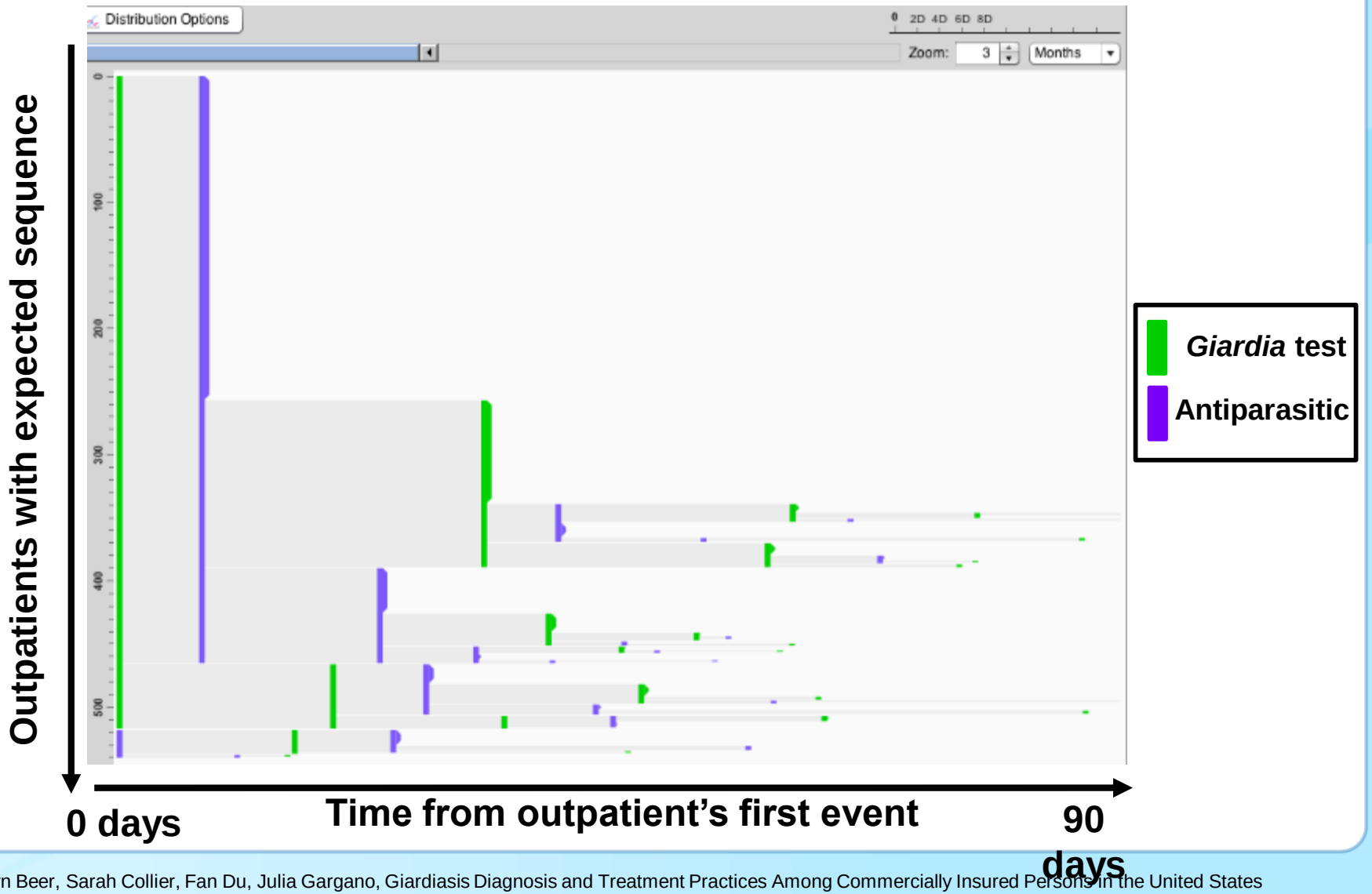
Data representing men diagnosed with cancer (small sample to explain the design).
Records have been aligned by the cancer diagnosis date (green).
We can see the different sequences of treatment with luteinizing hormone-releasing hormone (LHRH) (purple) and radiation therapy (brown). The most common first treatment in this group is the LHRH. The second most common is radiation therapy and we can see that it occurs earlier on average than LHRH as the distance from green to brown is shorter than the distance from green to purple.

Expected giardiasis clinical event sequence



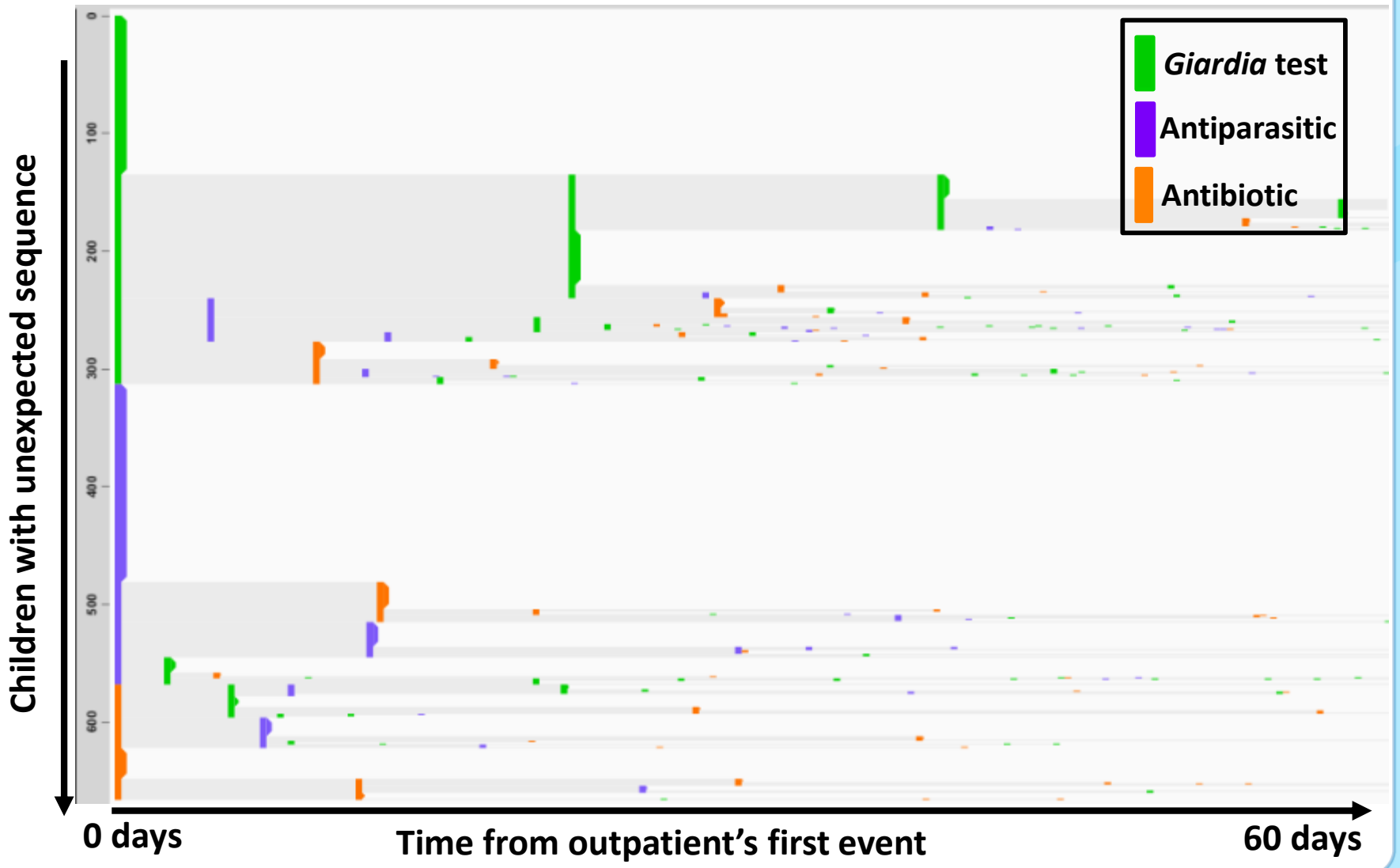
La giardiase (or giardiose ou encore lambliase), est une maladie parasitaire fréquente, le plus souvent bénigne lorsqu'elle est bien traitée.

18% of adults had the expected sequence (N=541)



Karlyn Beer, Sarah Collier, Fan Du, Julia Gargano, Giardiasis Diagnosis and Treatment Practices Among Commercially Insured Persons in the United States Clinical Infectious Diseases, 2017

Pediatric unexpected care sequences (n=807)



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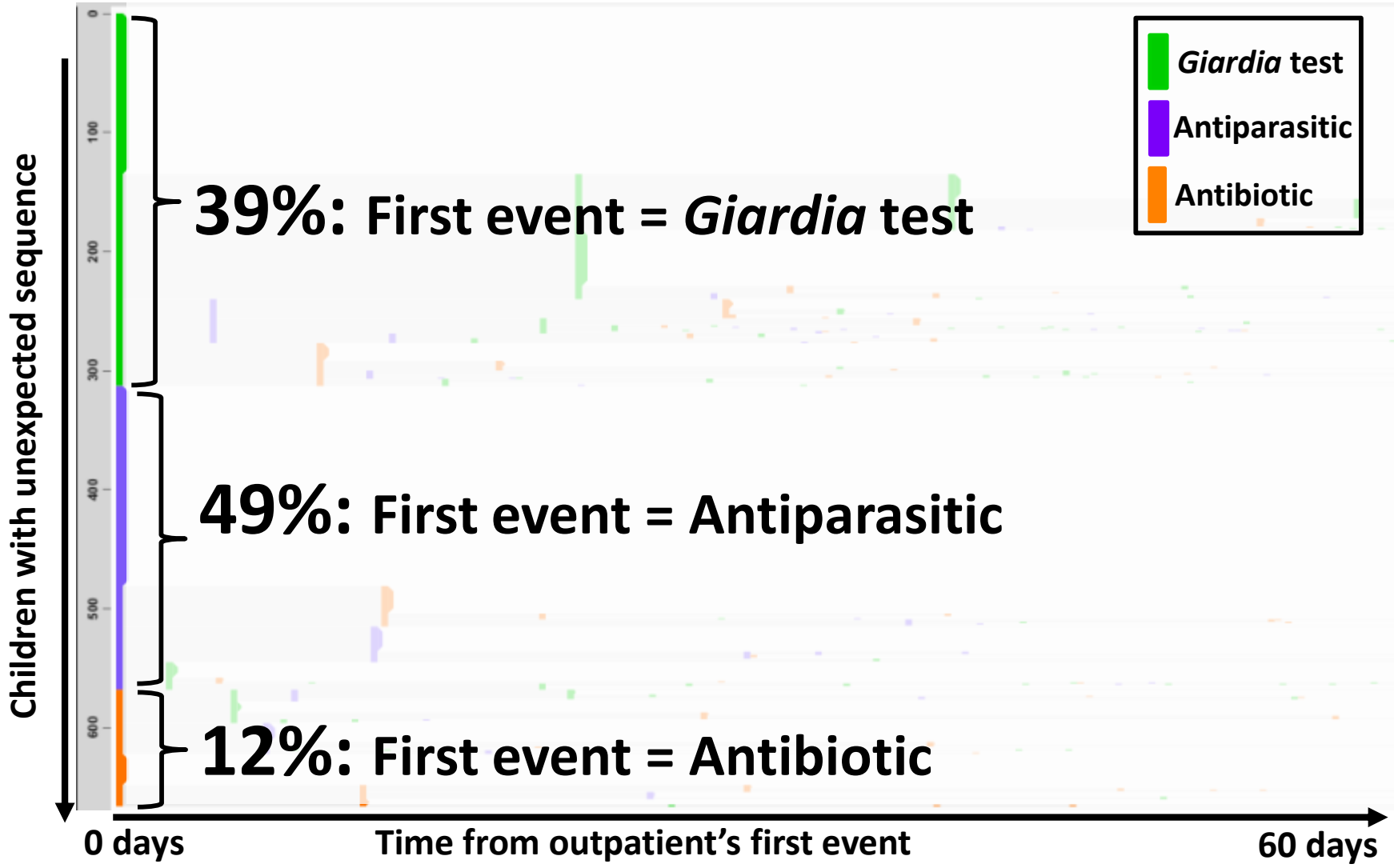

Karlyn Beer, Sarah Collier, Fan Du, Julia Gargano, Giardiasis Diagnosis and Treatment Practices Among Commercially Insured Persons in the United States
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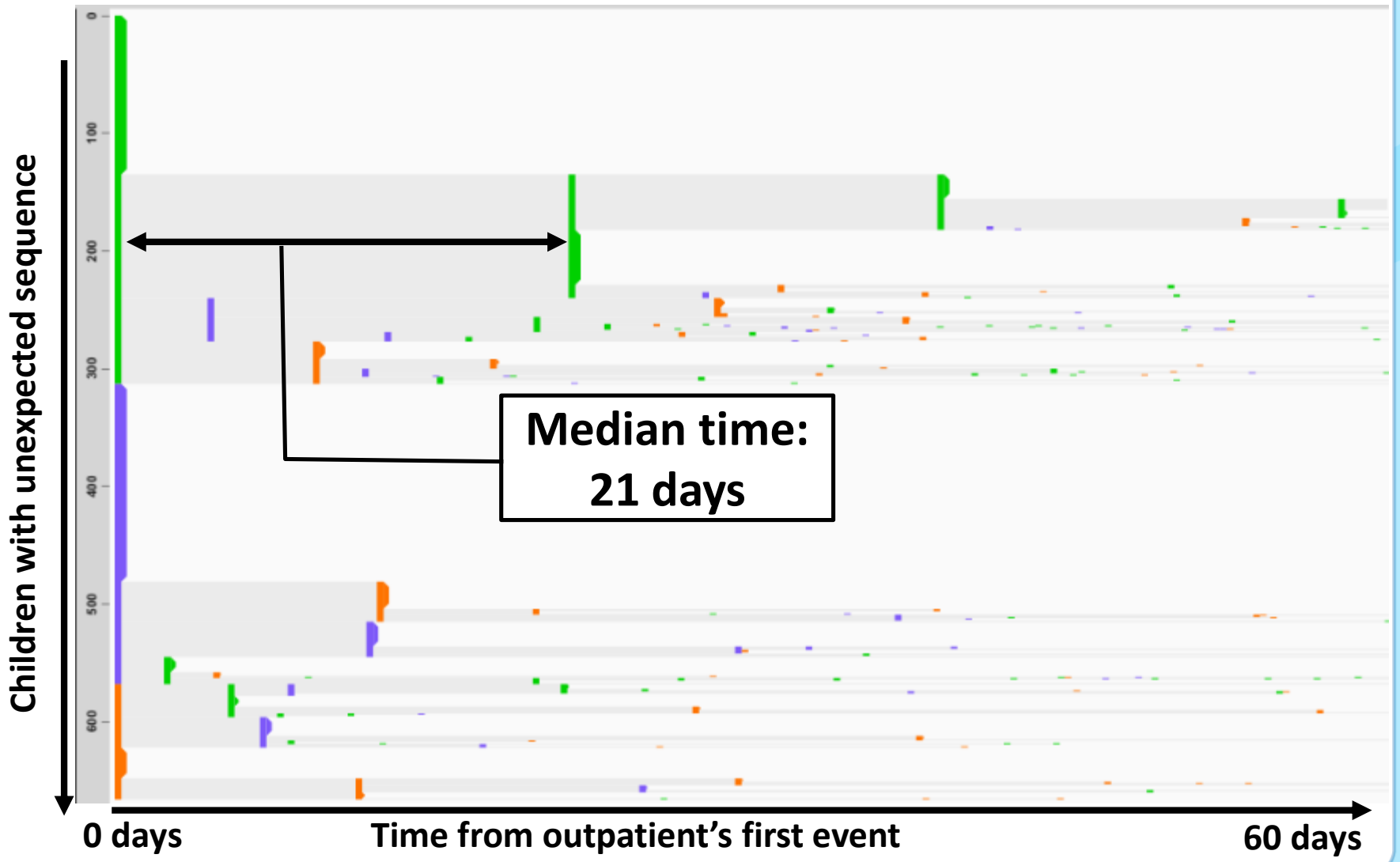
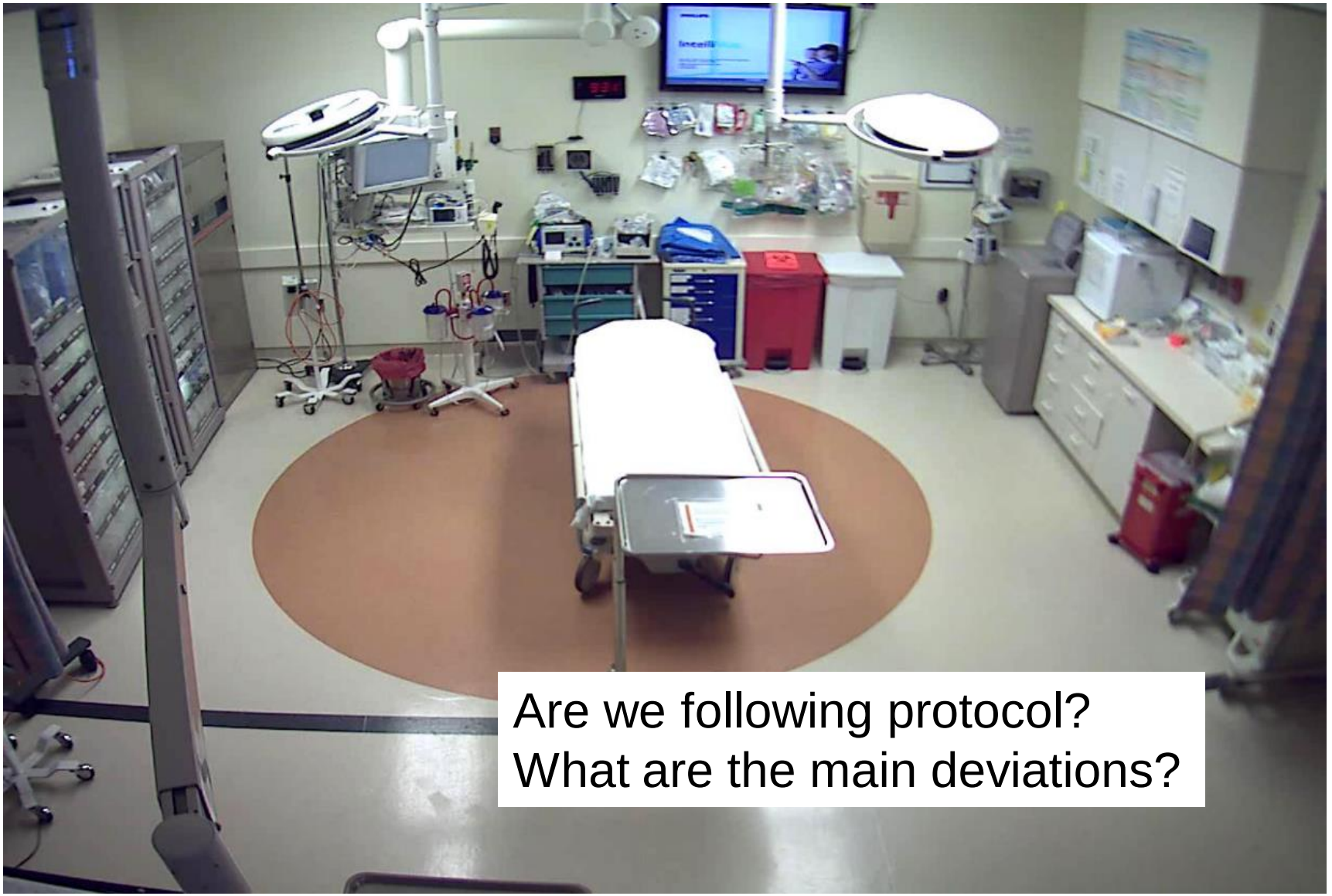


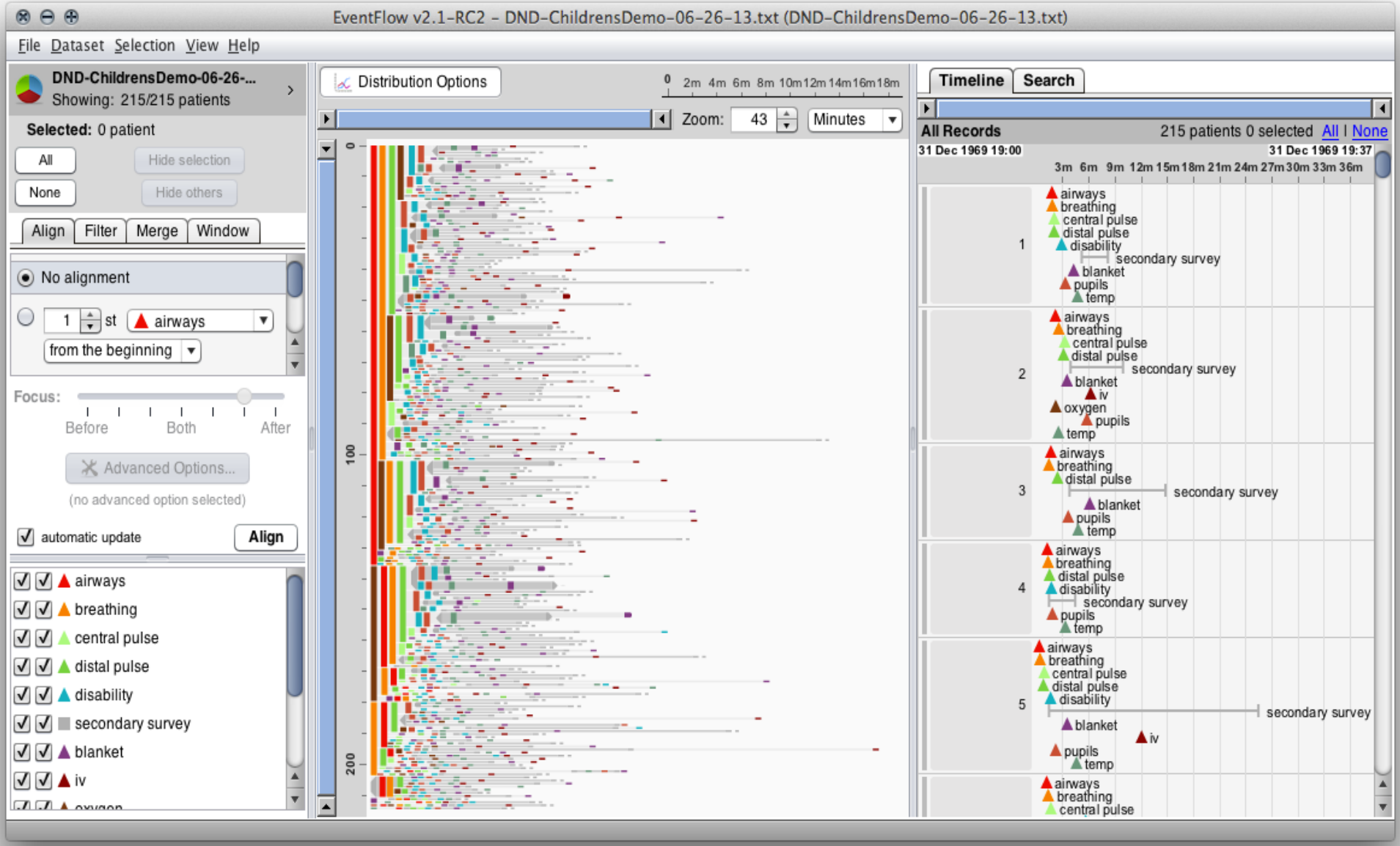
Karlyn Beer, Sarah Collier, Fan Du, Julia Gargano, Giardiasis Diagnosis and Treatment Practices Among Commercially Insured Persons in the United States
Clinical Infectious Diseases, 2017

Children's Hospital in DC: Trauma Bay



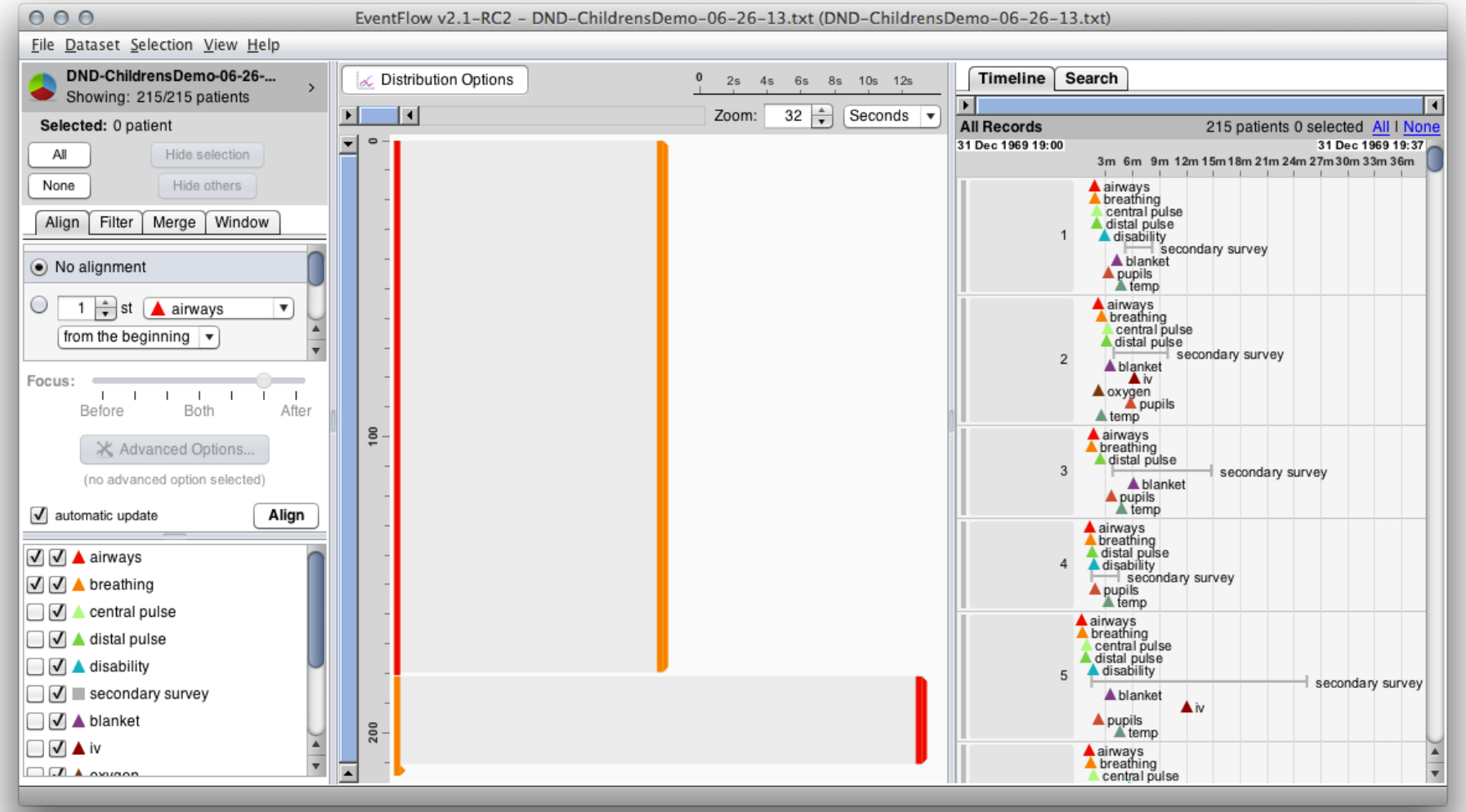
skip

Children's Hospital in DC: Trauma Bay

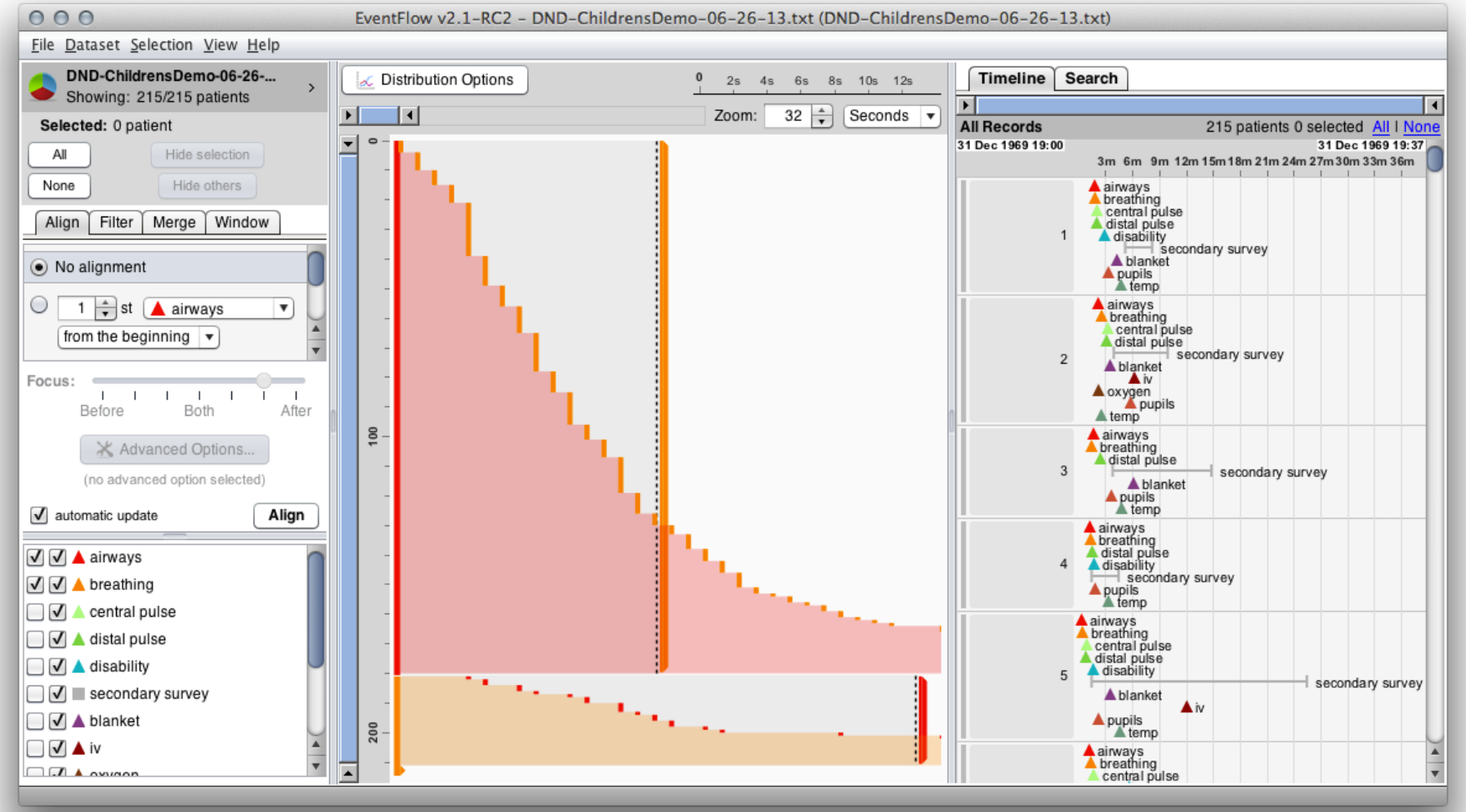


Focusing on the first two events

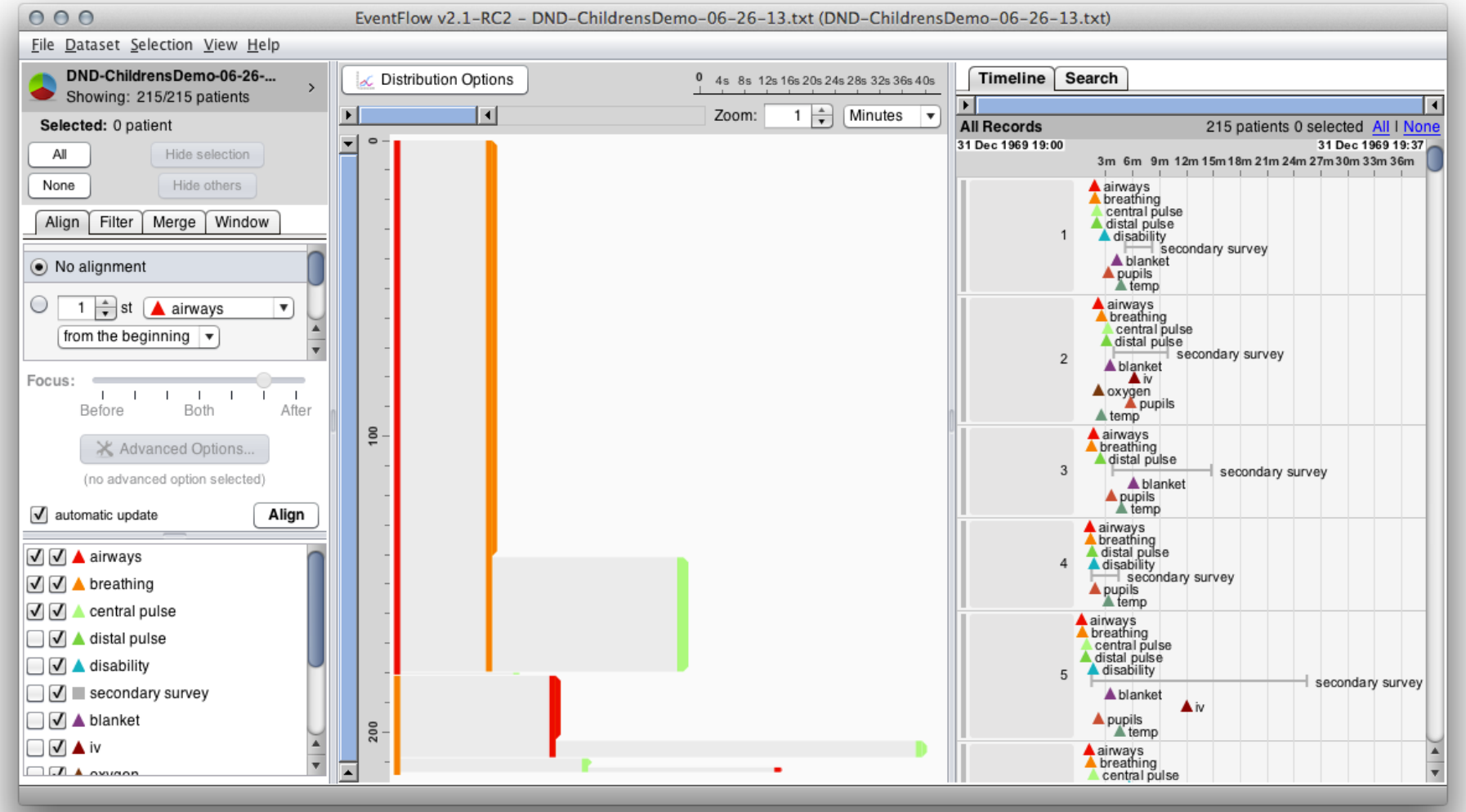
84% of patients are checked in the correct order.
The most common deviation is that the breathing is checked before the airways (14% of patients)
Reversed group takes longer on average than the correct sequence



Distributions

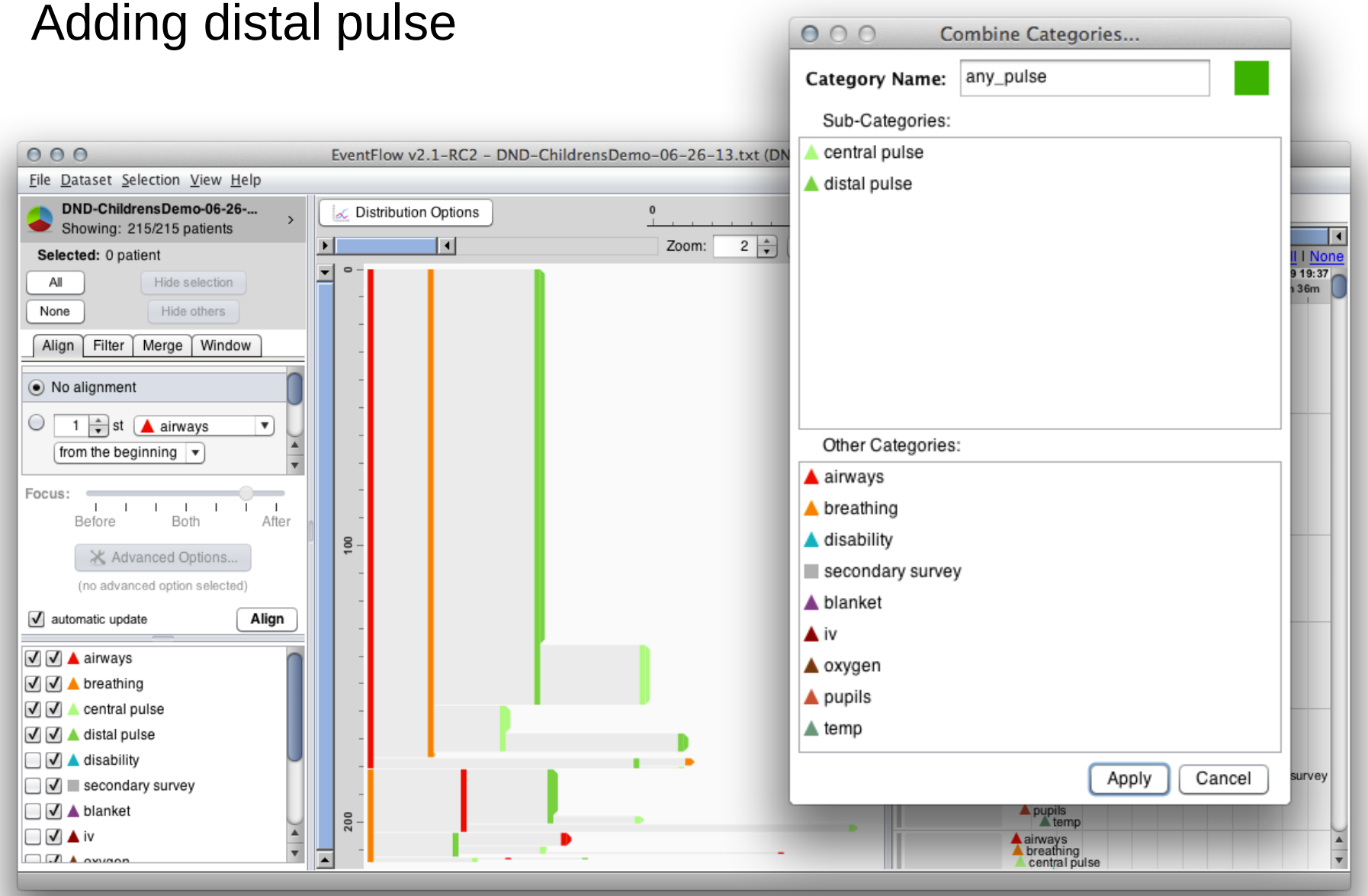


Adding third event type (central pulse)

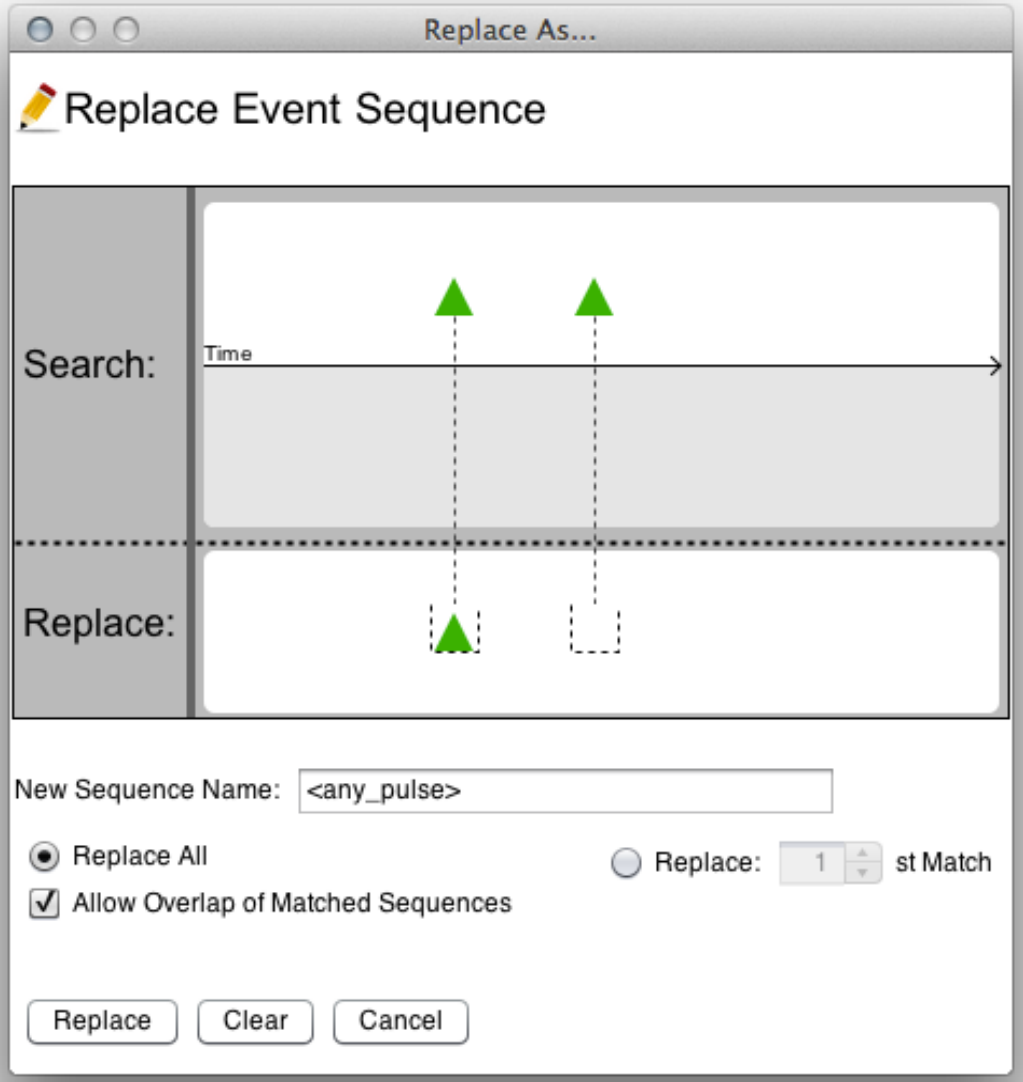


Combine the 2 pulse types

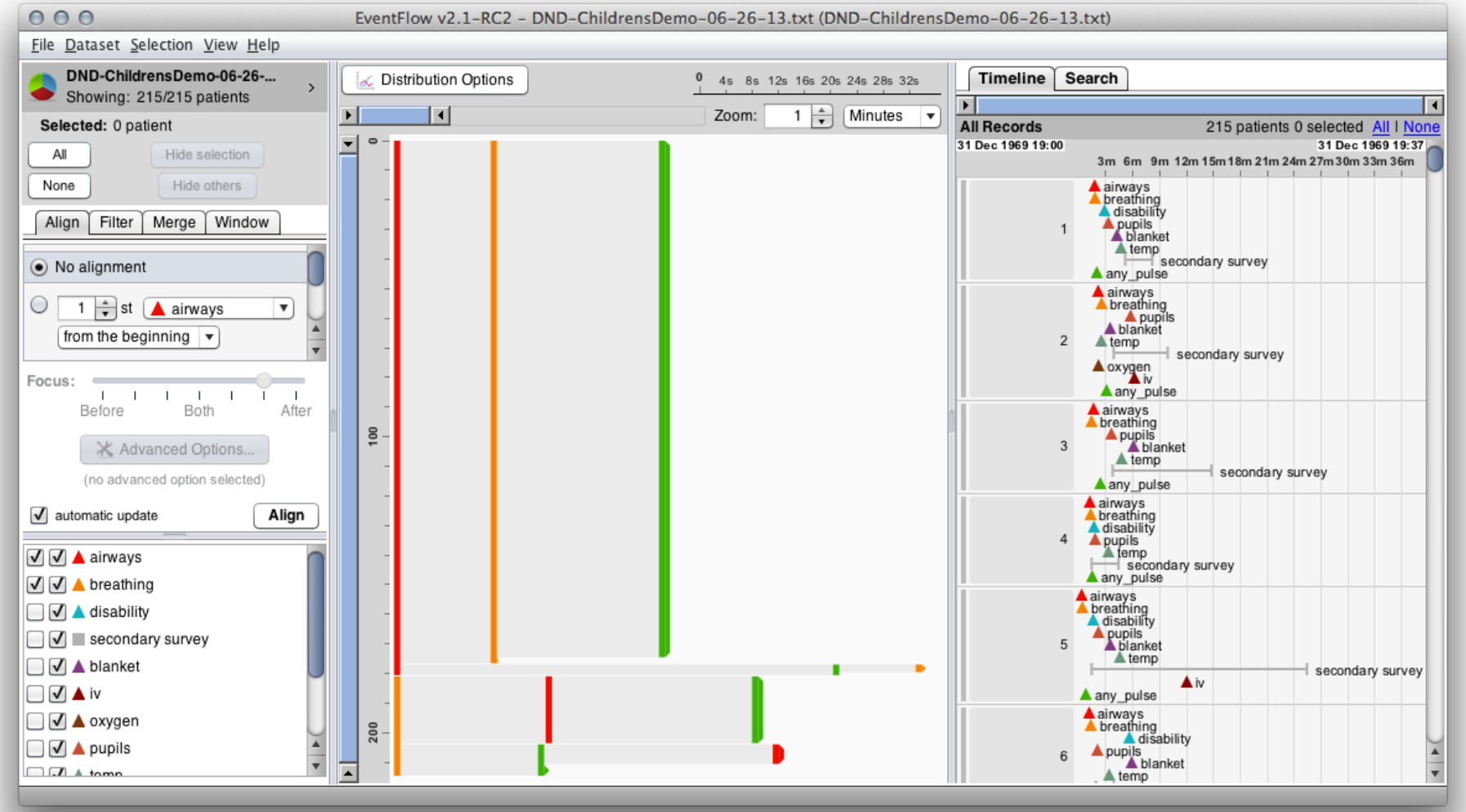
Adding distal pulse



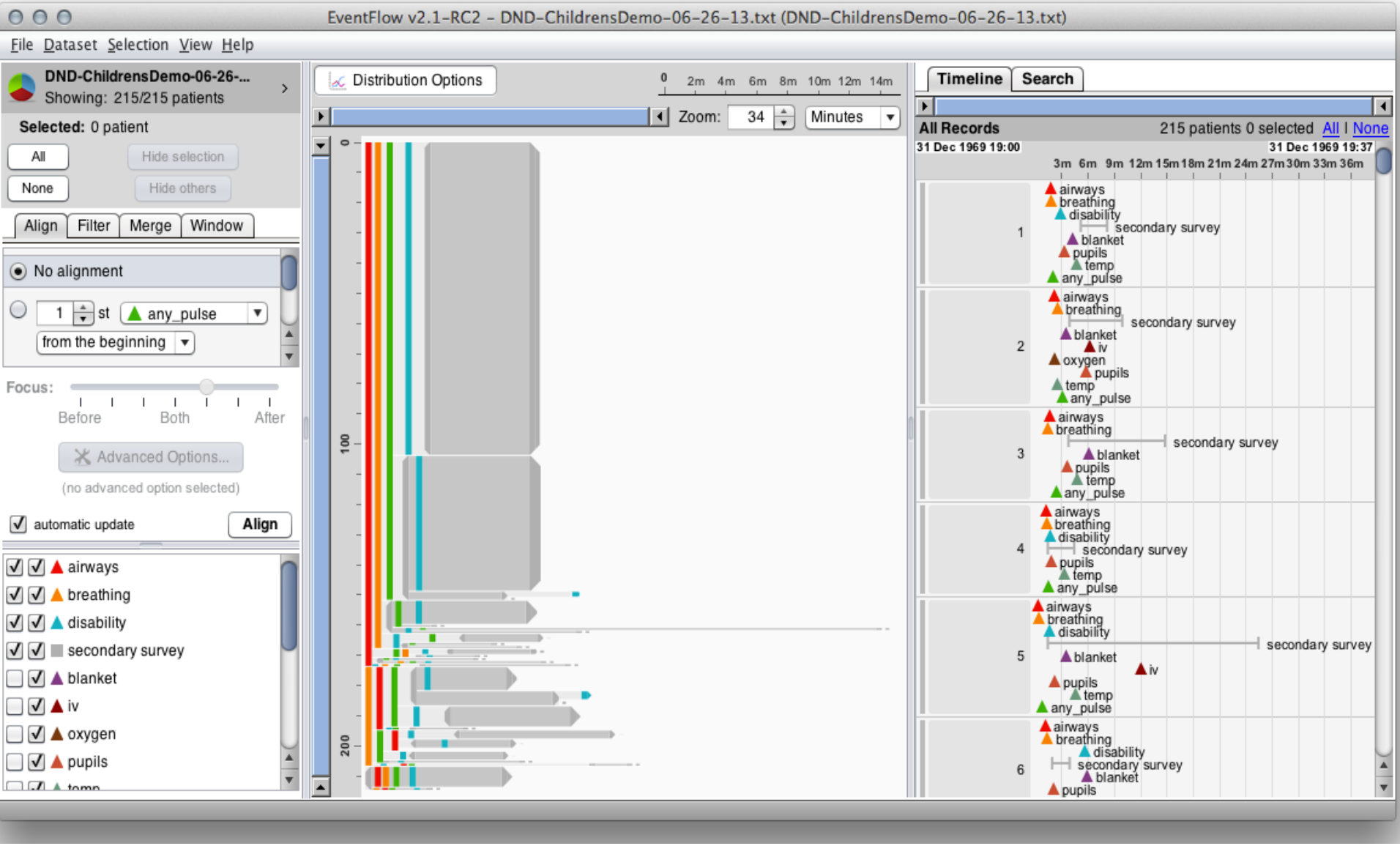
Graphical search & replace to remove duplicates



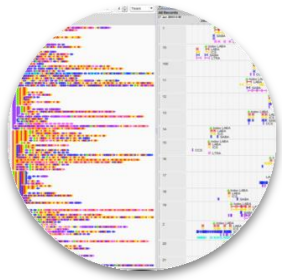
81% of the patients are treated in the correct order.
The largest deviation is still the airway and breathing being out of order,
but there are also instances where the circulation is checked too early.



Correct procedure only 48%
+ description of the 27 variations



Carter, E., Burd, R., Monroe, M., Plaisant, C., Shneiderman, B.
Using EventFlow to Analyze Task Performance During Trauma Resuscitation
In Proceedings of the Workshop on Interactive Systems in Healthcare (WISH), 2013



Goal= How are asthma meds used?

15M US Army records

→ only 182,000 records with asthma diagnostic (~1%)

→ only the asthma medication events

Further reduction # of events and unique complete sequences by 33%

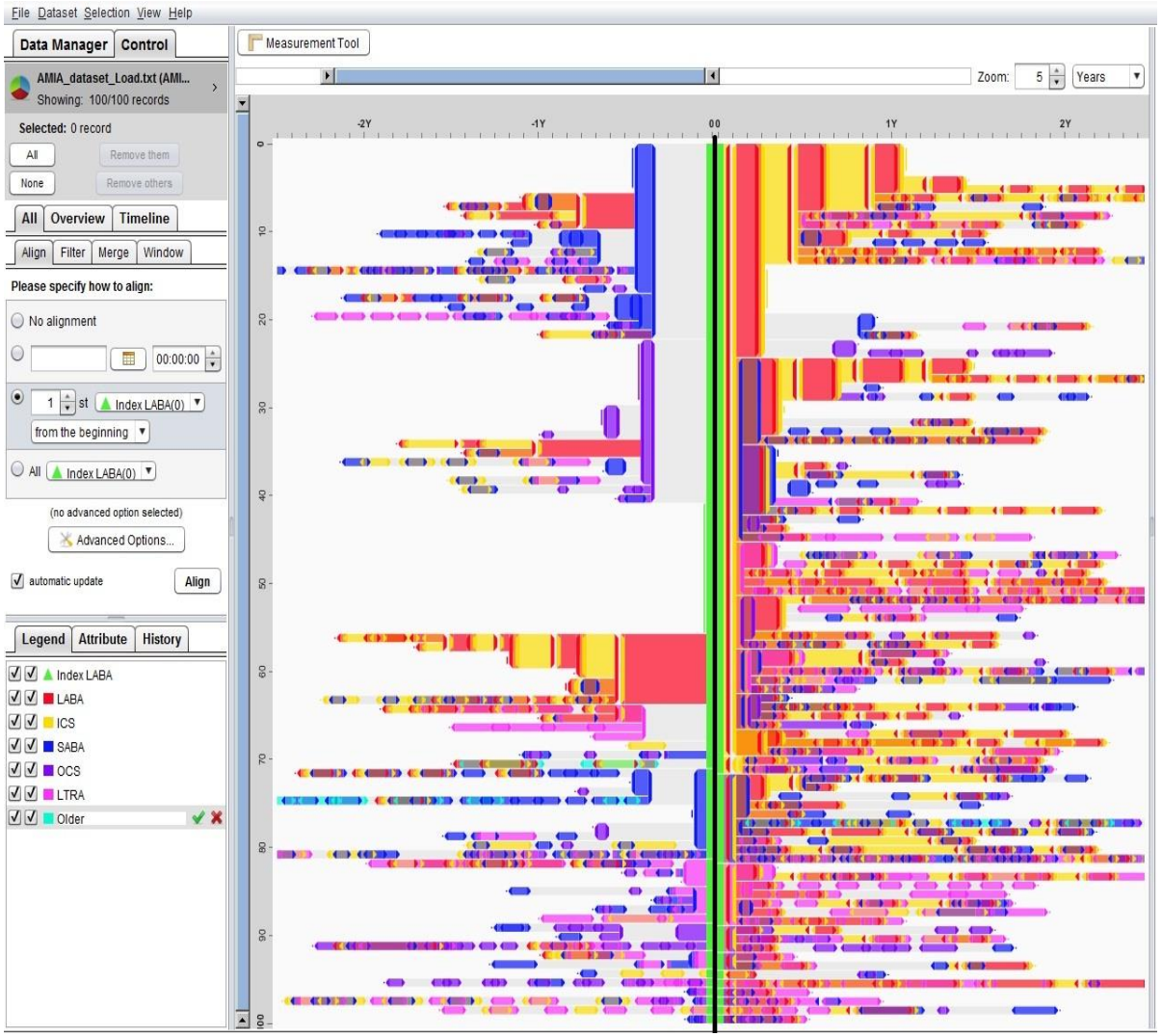
Extract from a database first

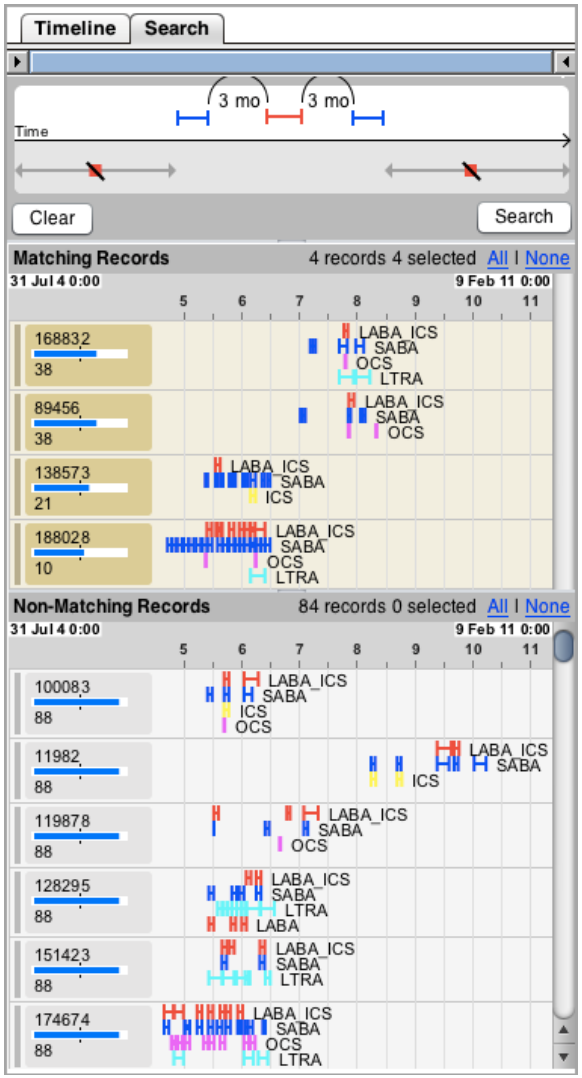
Interactively analyze sample within VA tool → strategy

Repeat with larger dataset

Another example

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

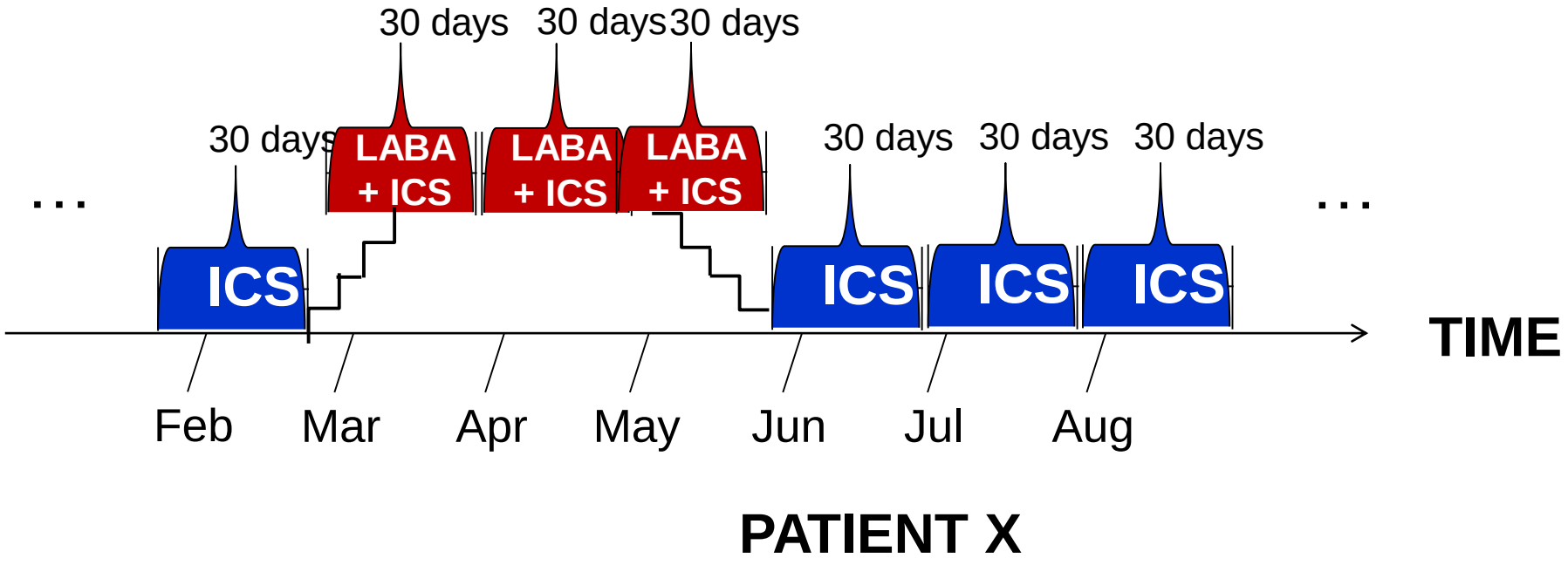




This case study is described in: http://hcil2.cs.umd.edu/trs/2014-26/2014-26.pdf
Catherine Plaisant, Megan Monroe, Tamra Meyer, Ben Shneiderman
Interactive Visualization (a book chapter in *Big Data and Health Analytics*, Marconi, K. and Lehman, H. (Eds), CRC Press – Taylor and Francis, pp 243-262, 2014.

skip

Asthma Therapy Example



PATIENT X

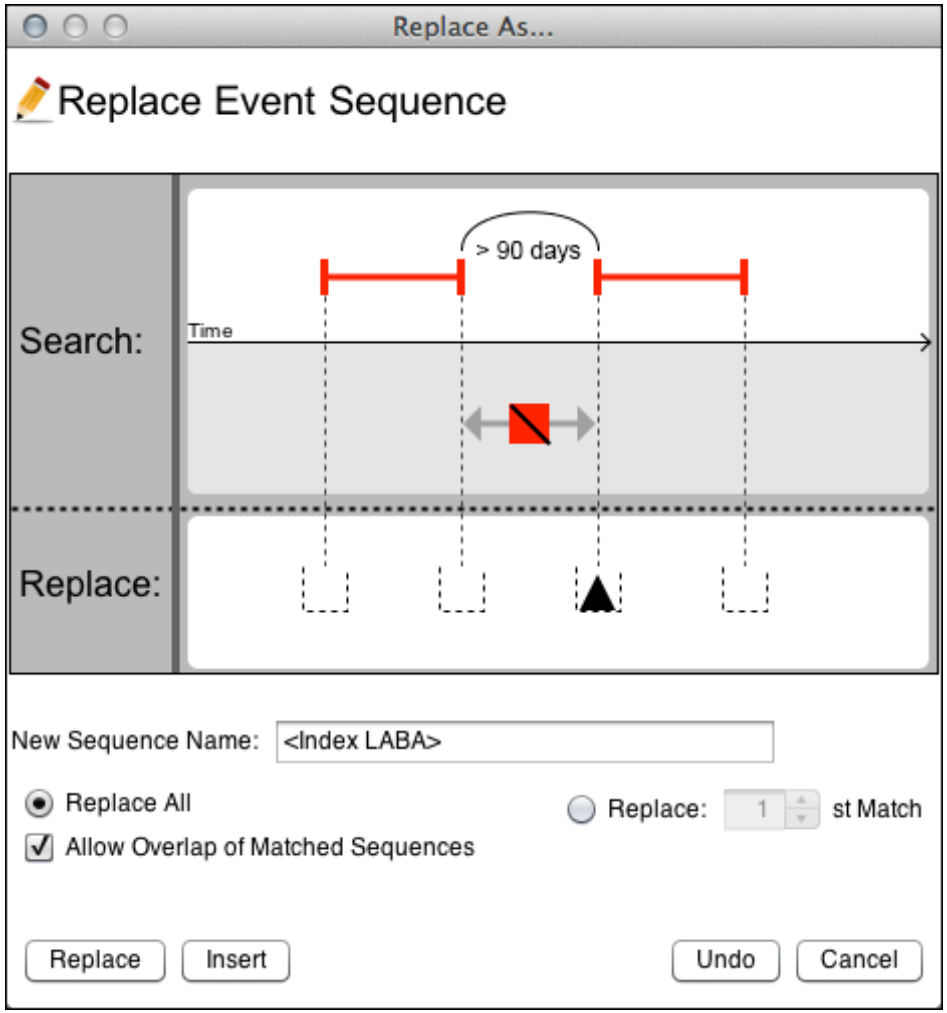
Acronyms

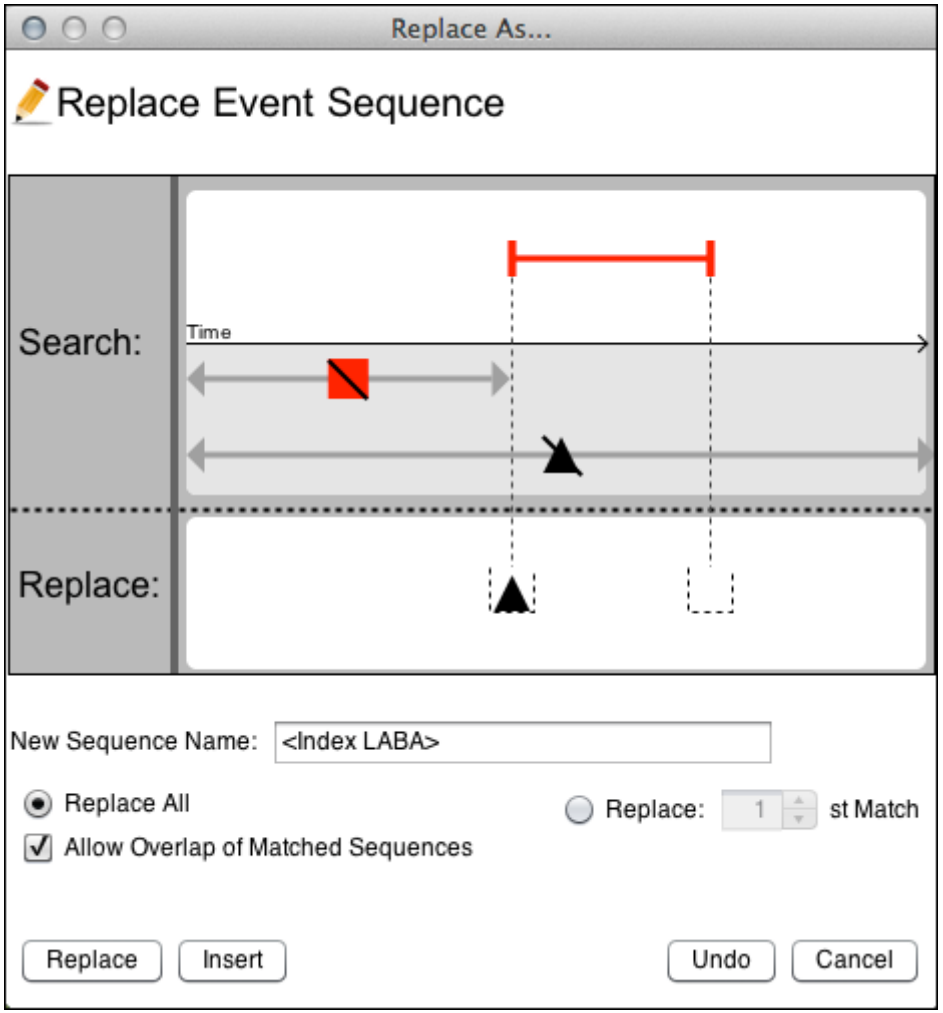
ICS: Inhaled Corticosteroid

LABA: Long-acting Beta Agonist

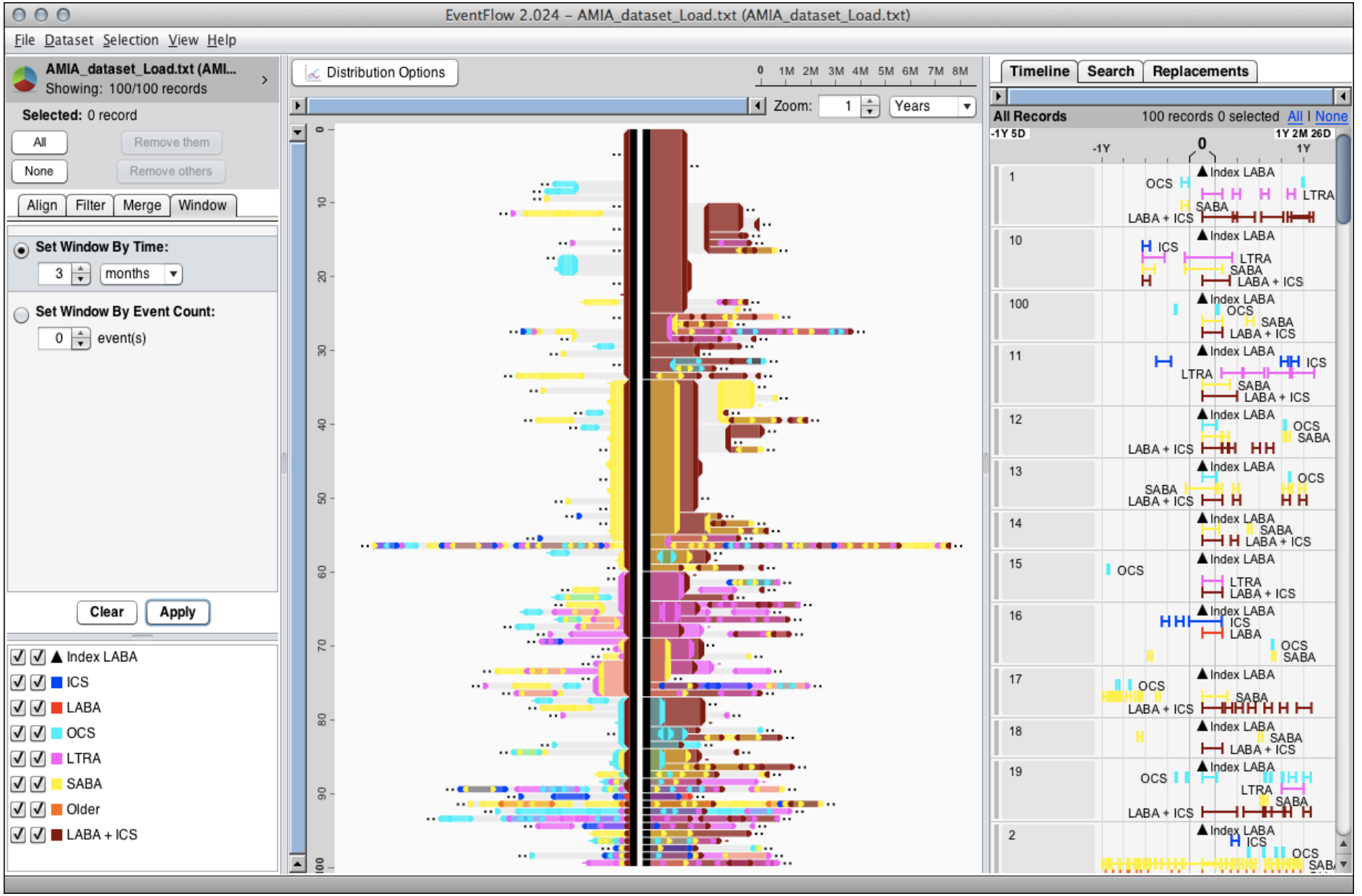
LABA + ICS: LABA combined with ICS

Search and Replace: Identifying the Index LABA

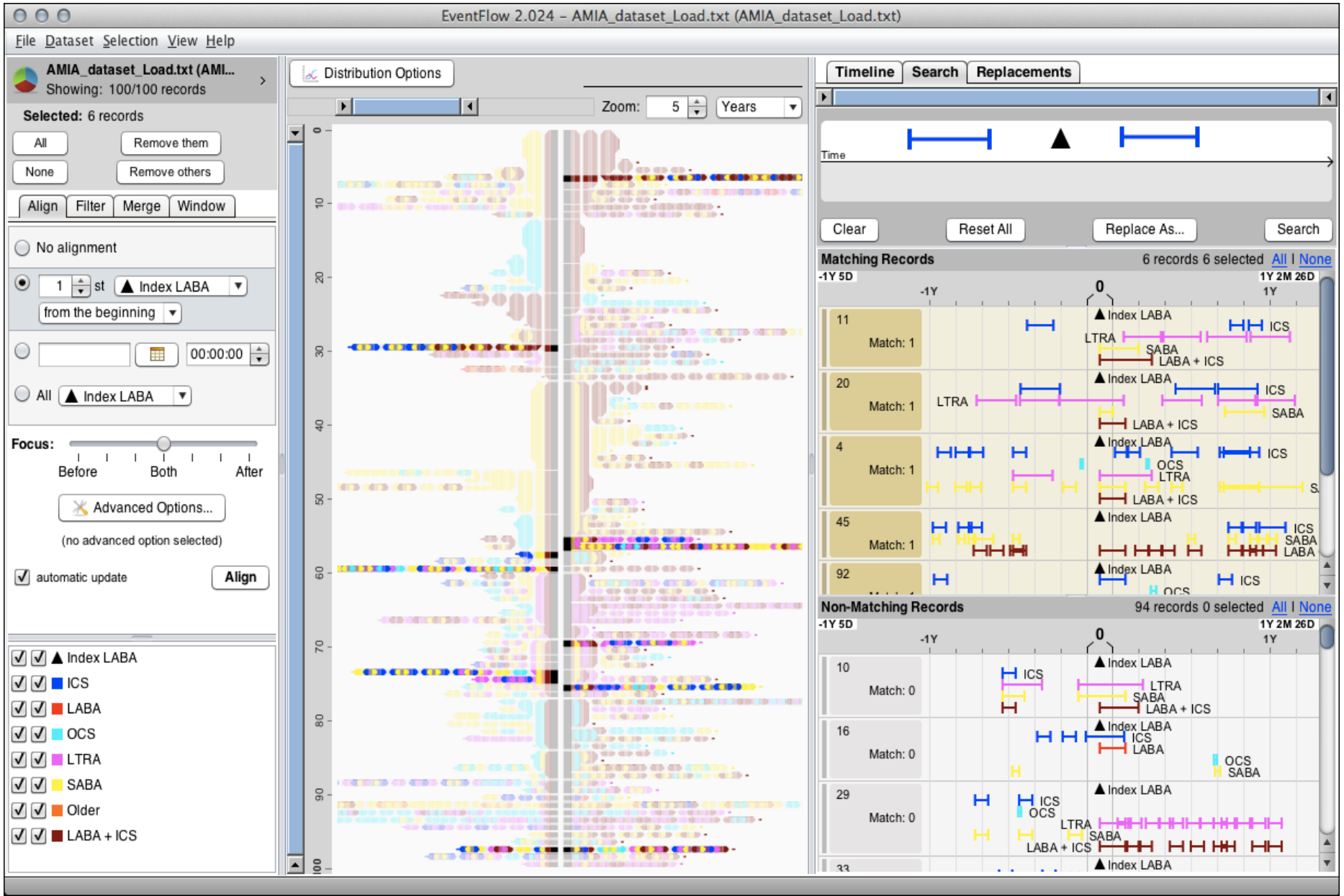




Limit to the 3 Months Surrounding the Index LABA



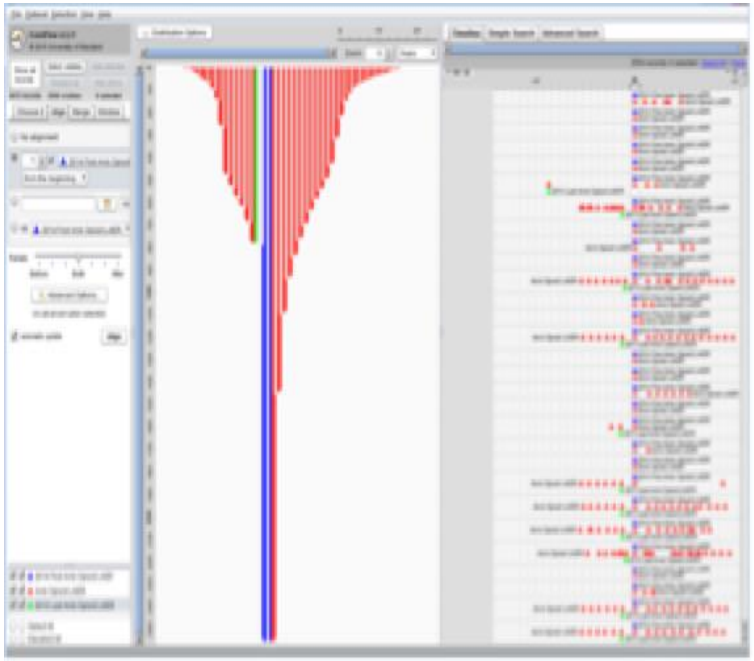
Find Patients with ICS Before and After LABA

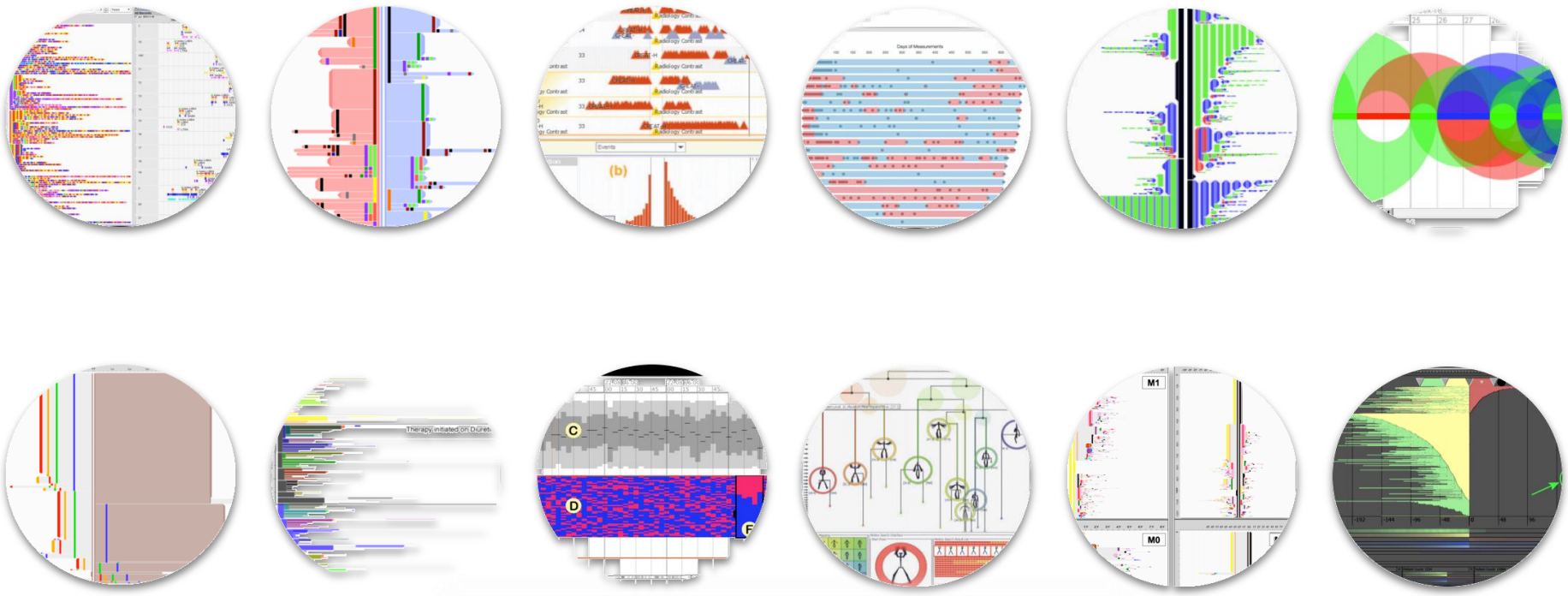


From: Gigi Lipori
Date: Friday, April 24, 2015 at 11:45 AM

Got everything to work. **Worth its weight in gold (again).**

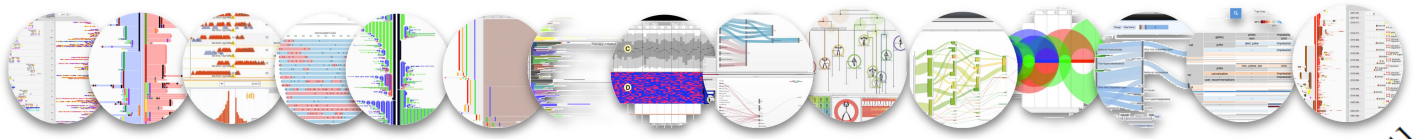
All are er/la opioid scripts
…/…
That would be a pain in the neck to code up.





20 case studies

20 case studies



15 strategies

	ASTHMA [38]	BASKETBALL [40]	CONTRAST [59]	DEVIATION [14]	DRUG [39]	EHR COHORTS [19]	EPILEPSY [39]	FOURSQUARE [45]	HEART [44]	HYPERLIPIDEMIA [46]	HYPERTENSION [56]	LIVER [33]	LOG [39]	MEMuRY [32]	MOTION [12]	PROSTATE CANCER [43]	PROSTATE CANCER 2 [11]	TWITTER [62]	VIOLENCE [47]	WORKFLOW [39]
Extraction	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●
S1: Goal-Driven Record Extracting	●	●		●	●		●	●	●	●	●	●	●			●	●	●		●
S2: Goal-Driven Event Category Extracting								●	●	●	●		●				●			
S3: Identifying Features Linked to Outcome																				
S4: Aligning	●	●	●	●	●		●	●	●	●		●	●		●	●	●	●	●	●
S5: Temporal Windowing					●	●	●	●	●	●	●	●	●	●	●	●	●			●
S6: Selecting Milestone Events								●	●	●			●							
S7: Random Sampling of Records																				
Folding	●				●															
S8: Temporal Folding		●	●					●	●				●						●	
Pattern Simplification	●			●	●		●	●	●	●	●	●	●		●	●	●	●	●	●
S9: Grouping Event Categories				●		●		●	●	●	●		●	●						●
S10: Coalescing Repeating Point Events into One					●							●		●						
S11: Coalescing Repeating Interval Events into 1	●				●															
S12: Converting Hidden Complex Events into 1	●			●	●			●		●										
S13: Bucketing by Time Period																				
Iteration	●				●															
S14: Analyzing Small Subset then Larger One					●							●			●			●		
S15: Partitioning																				

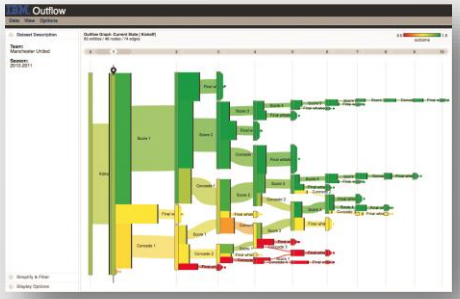
Du et al. (2017) Coping with Volume and Variety in Temporal Event Sequences: Strategies for Sharpening Analytic Focus
IEEE Transactions Visualization and Computer Graphics

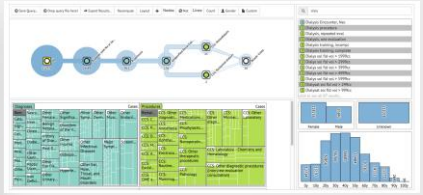
Event Analytics

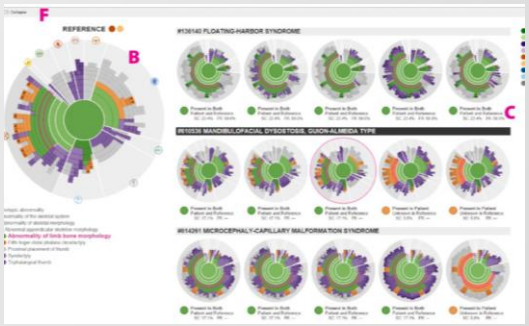
to:

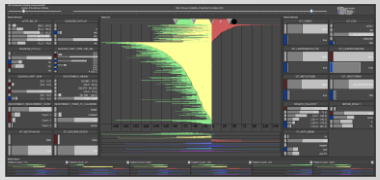
review the data from individual records
search for temporal patterns of interest
summarize all the event sequences
perform **data transformations**
select cohorts of interest for further studies

Many other projects in event analytics









Thank you

Thank you to U. of Maryland colleagues

Ben Shneiderman
Fan Du, Sana Malik
Megan Monroe, Krist Wongsuphasawat, David Wang

+ all case study partners

hcil.umd.edu/eventflow

plaisant@cs.umd.edu

Good visualization tool you can use for free as a studer
(but no event sequence analysis)

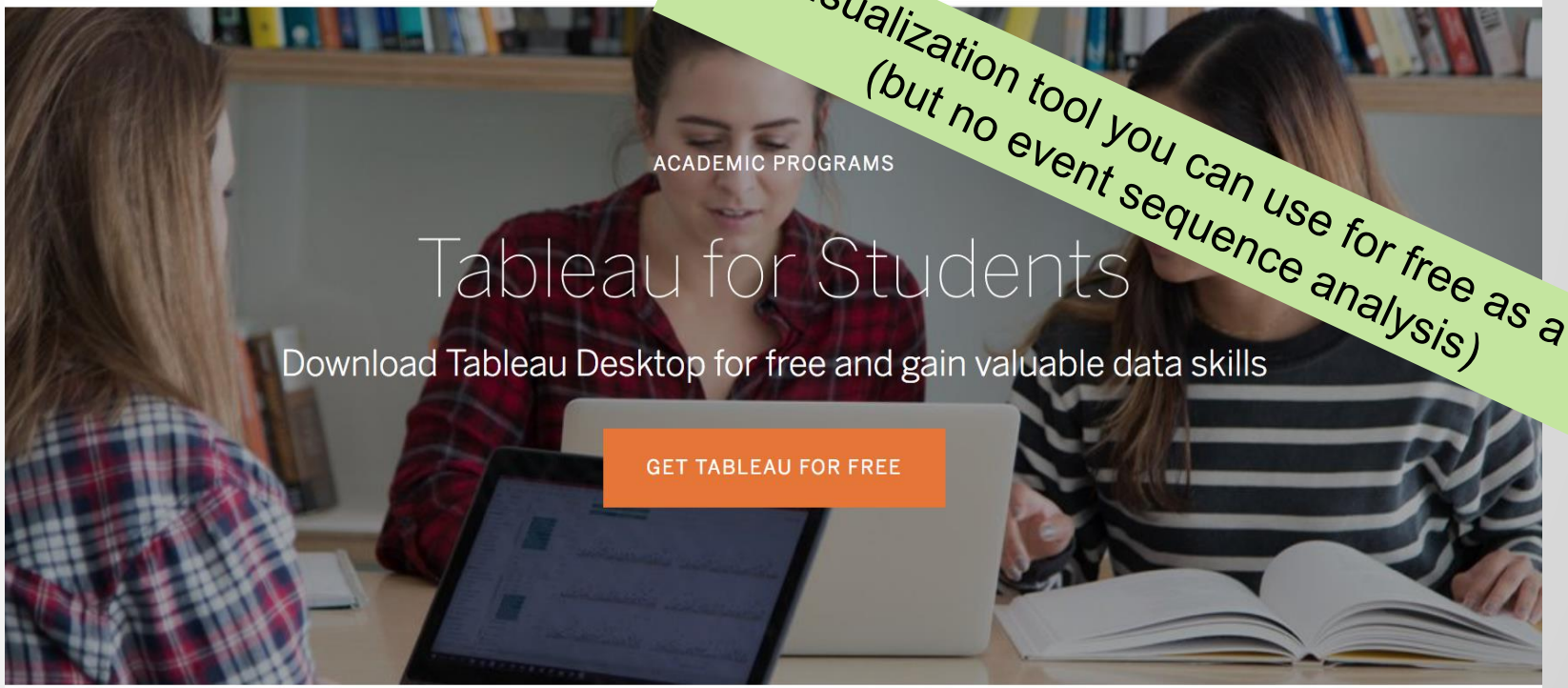


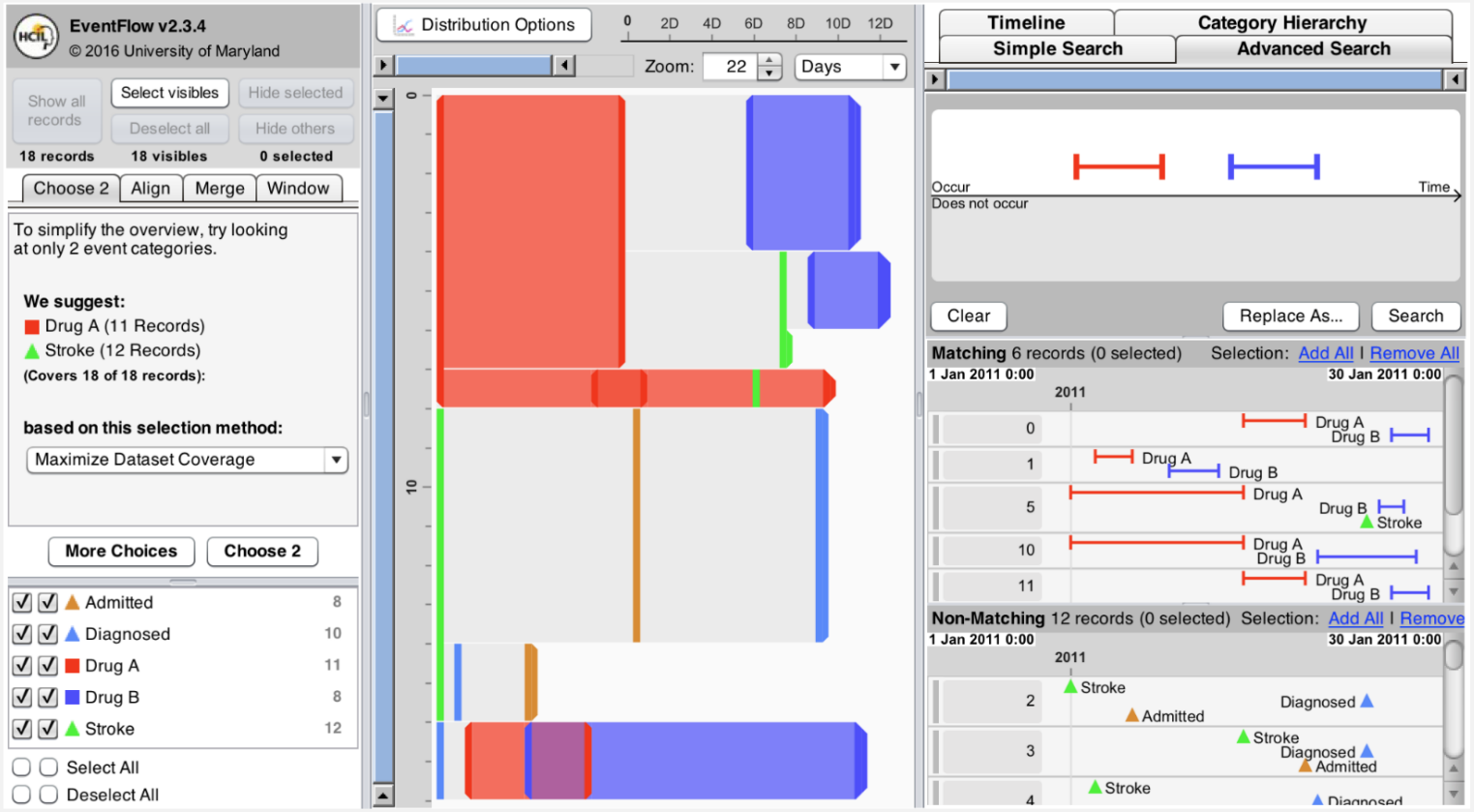
Tableau Desktop: Free to download, easy to use

Analysis at the speed of thought

See the drag-and-drop analytics solution built for speed and ease of use. Start building the analytical skills employers are looking for in today's data-driven workplace.

EventFlow: Visual Analysis of Temporal Event Sequences and Advanced Strategies for Healthcare Discovery

JUMP TO: FEATURES | PARTICIPANTS | PRESENTATIONS | VIDEOS | DOWNLOAD & LICENSING | USER SUPPORT | PUBLICATIONS | PRESS | RELATED PROJECTS



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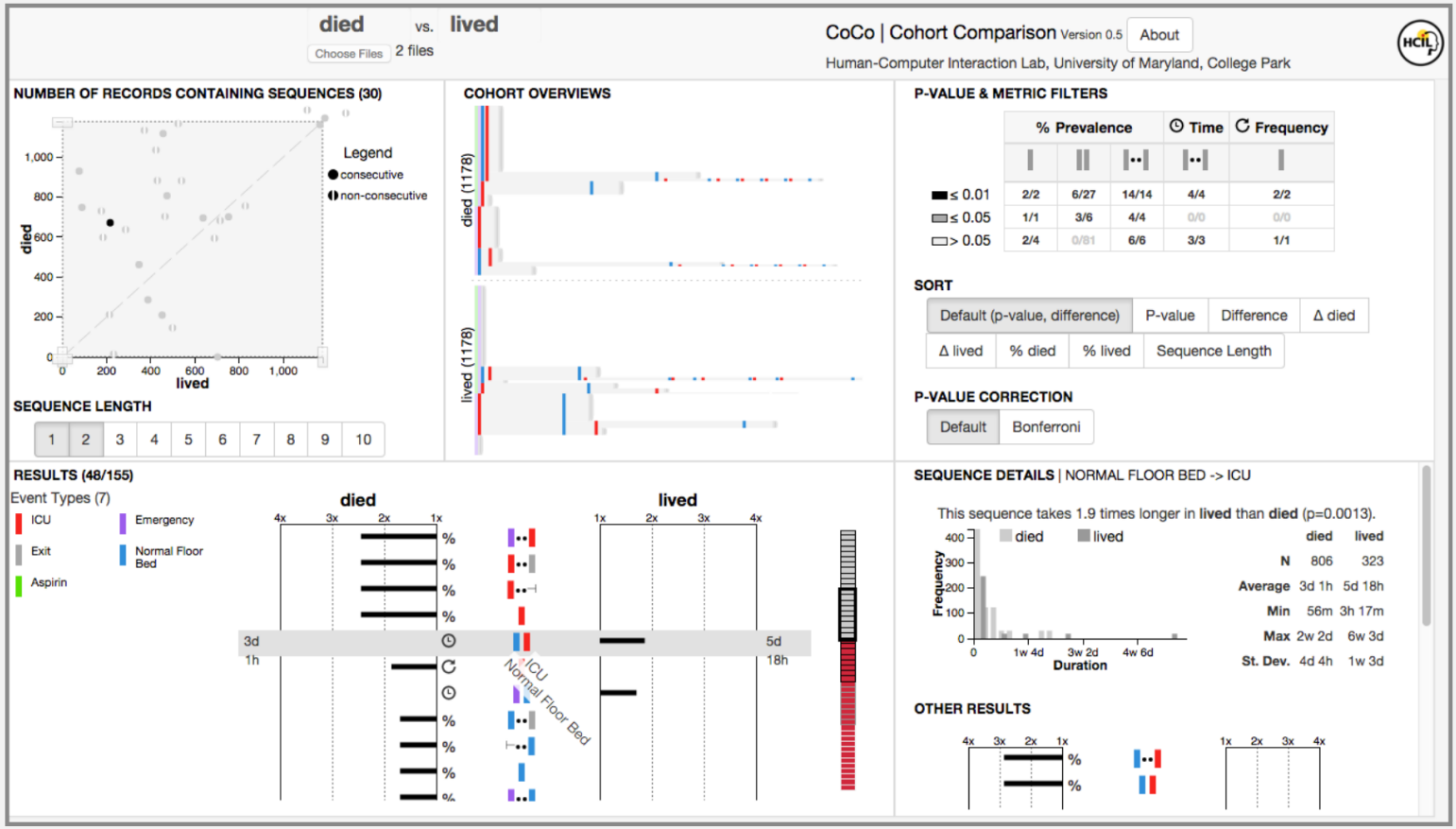
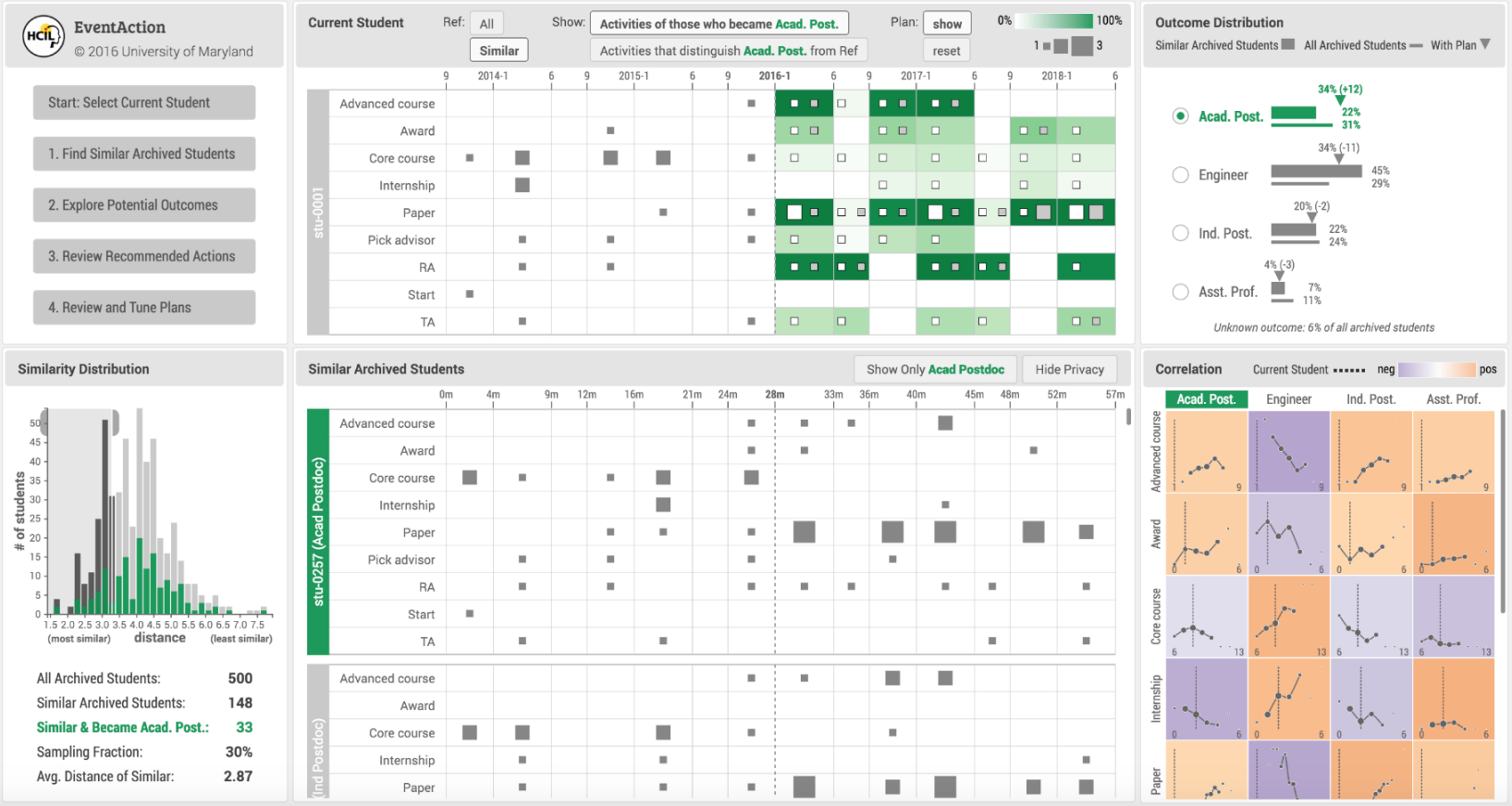
CoCo: A Visual Analytics Tool for Comparing Cohorts of Event Sequences

Jump to: Participants | News | Software | Publications | Related Projects



EventAction: Visual Analytics for Temporal Event Sequence Recommendation



SUMMARY

EventAction is a prescriptive analytics interface designed to **present and explain recommendations of temporal event sequences**. EventAction provides a visual analytics approach to (1) identify similar records, (2) explore potential outcomes, (3) review recommended temporal event sequences that might help achieve the users' goals, and (4) interactively assist users as they define a personalized action plan associated with a probability of success. EventAction's usage scenarios include **student advising**, **treatment formulating**, **customer retention**, and **sports coaching**.

Thank you

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+ all case study partners

hcil.umd.edu/eventflow

plaisant@cs.umd.edu