

# FINDING PATTERNS IN TEMPORAL DATA

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UNIVERSITY OF MARYLAND

*27th HCIL Symposium  
May 27, 2010*



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# TEMPORAL CATEGORICAL DATA

- A type of time series

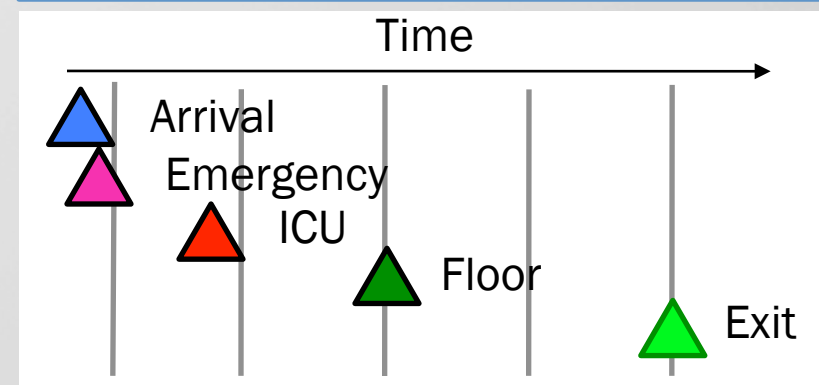
*Numerical* *Event*

Stock: Microsoft		
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	



*Category* *Event*

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	



# TEMPORAL CATEGORICAL DATA



**Electronic Health Records:** symptoms, treatment, lab test

**Traffic incident logs:** arrival/departure time of each unit

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

**Others:** web logs, usability study logs, etc.



10+ years work on temporal visualization  
(mostly on Electronic Health Records)

# LIFELINES



SINGLE RECORD


[Plaisant et al. 1998]

<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: %-,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

Hosp.: Appendectomy, Pneumonia, KneeSurgery

Tests: BloodEKG, EKG, Xray, Blood, Blood, Blood, Blood, Sonogr

Meds.: Prozac, Heartdrug, Ventolyn, Antib., Advil, Advil, Insulin, Insulin

Others: PhysicalTherapy, LowSaltFatDiet

Immun.: TBtest, Tetanus, Flu

DATE: 5-19-98 PATIENT ID: [redacted] 17hr/3.8

**LifeLine Control Panel**

Layout Label

- Default
- Quick Compact
- Slow Compact
- Chronologically Ordered
- Event Ordered

Apply OK Cancel

Warning: Applet Window

# LifeLines – Single Patient



Washington  
Hospital Center  
*MedStar Health*

SEARCH

GO

Call 202-877-DOCS for an appointment










WORKING WITH PHYSICIANS AT  
**WASHINGTON HOSPITAL CENTER**



# EXAMPLE DATA

- Patient transfers

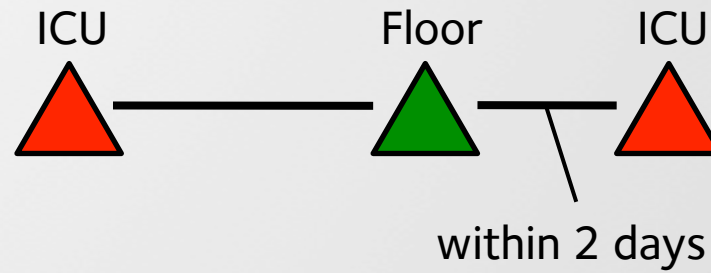
---

	ARRIVAL	Arrive the hospital
	EMERGENCY	Emergency room
	ICU	Intensive Care Unit
	INTERMEDIATE	Intermediate Medical Care
	FLOOR	Normal room
	EXIT-ALIVE	Leave the hospital alive
	EXIT-DEAD	Leave the hospital dead

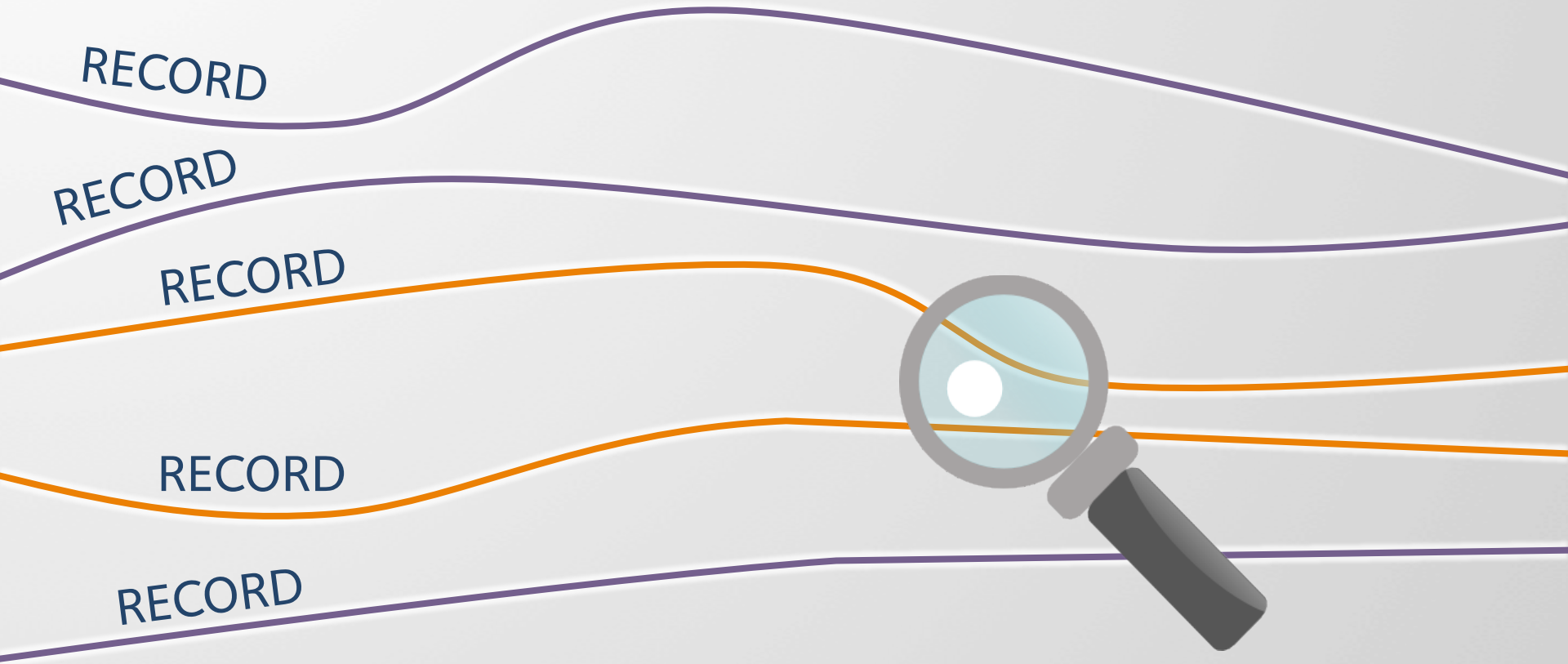
---

# TASKS

- Example: Finding “Bounce backs”



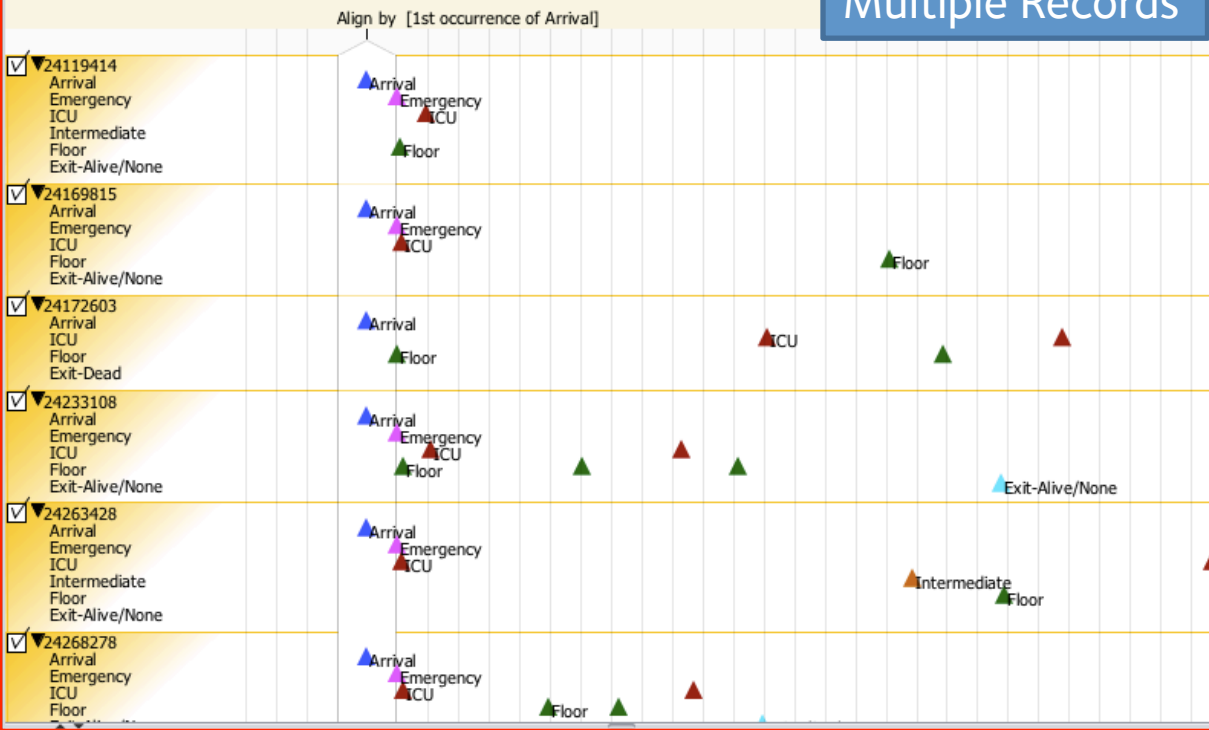
# LIFELINES 2



[Wang et al. 2008, 2009]  
<http://www.cs.umd.edu/hcil/lifelines2>

All Records Records 20/309 20

Multiple Records



ARF (Align-Rank-Filter) Framework

Record ID

Filter by...

- Sequence
- ▲ Arrival(309)
- ▲ ICU(306)
- ▲ Floor(256)
- ▲ ICU(306)
- None

Keep Selected Remove Selected

Reset Filters

Collapse all Save Records as New Group

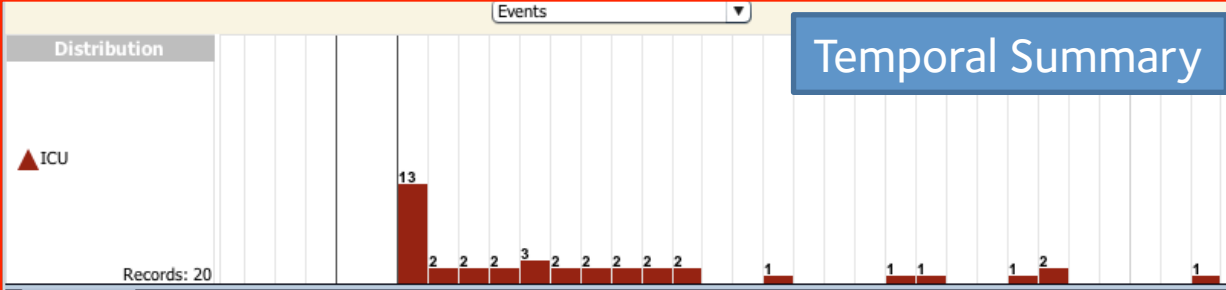
Add Records To... New Group...

Show Group Membership

More Controls

Events Icons Labels Alignment

Temporal Summary



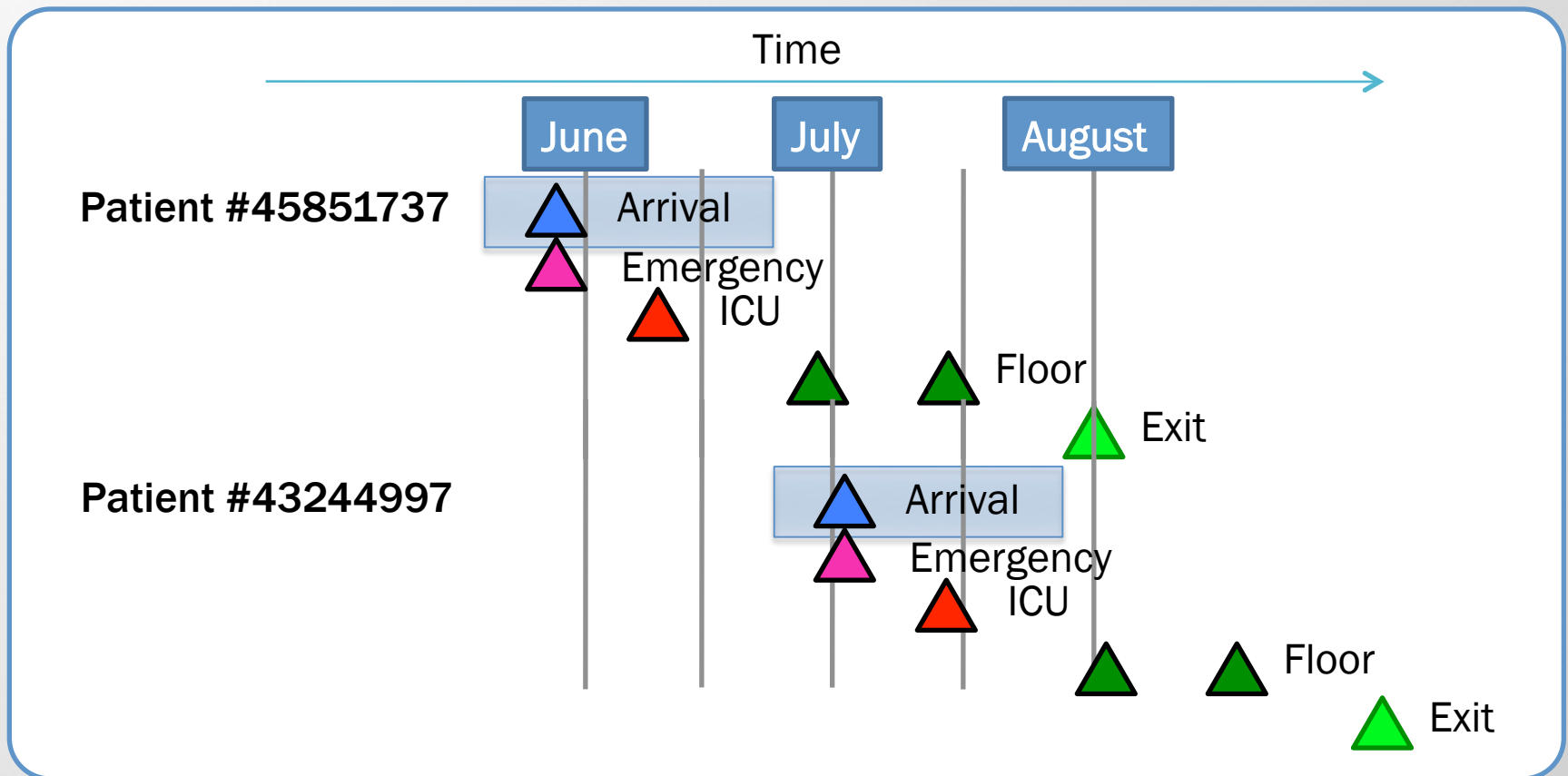
- MedStar
- ▲ ICU
- ▲ Intermediate
- ▲ Floor
- ▲ Exit-Alive/None
- ▲ Exit-Alive
- ▲ Exit-None
- ▲ Exit-Dead

Edit Events

# LifeLines2 – Search and Visualize

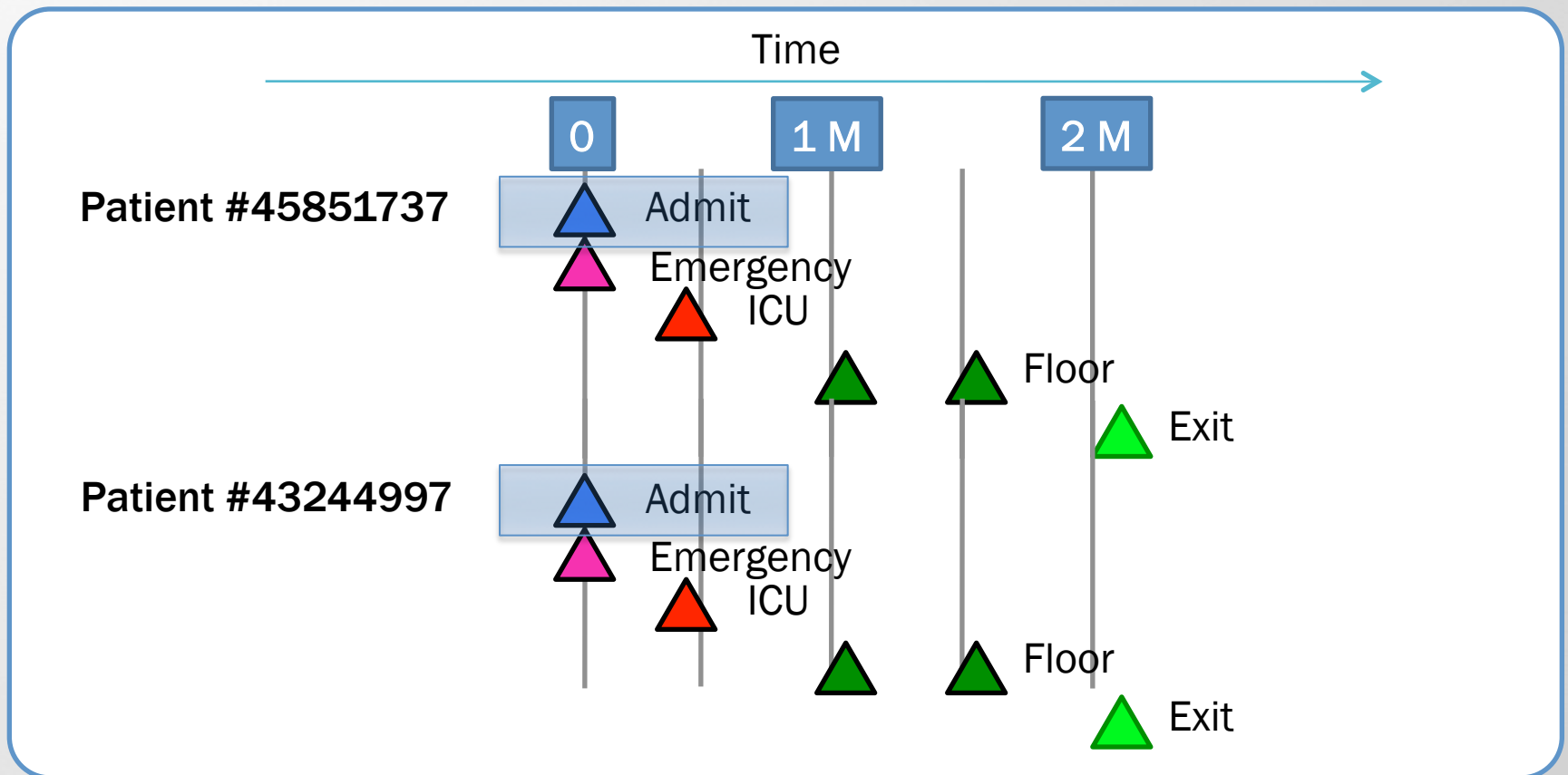
# ALIGNMENT

- Sentinel events as reference points

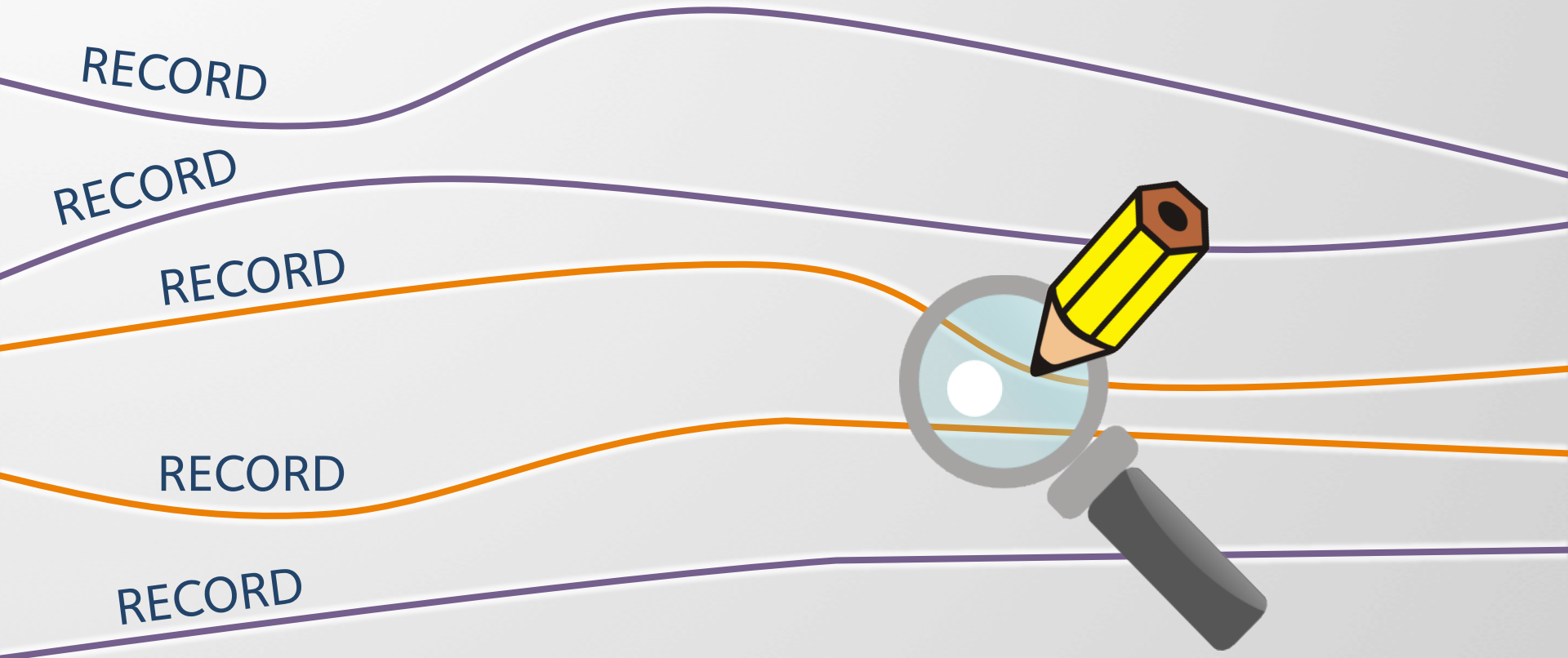


# ALIGNMENT (2)

- Time shifting



# SIMILAN



[Wongsuphasawat & Shneiderman 2009]  
<http://www.cs.umd.edu/hcil/similar>

Similan - /Volumes/DATADISK/Documents/FlexWorkspace/Similan/bin-debug/data/A\_Demo\_Proposal/ICU\_2... Showing 309 / 309 records

File Edit Settings Help

\*Target edit 0 1D 2D 3D 4D 5D 6D 7D 8D 9D 10D 11D 12D

Custom Admit Floor ICU

130244866 2/17/2010 Admit ICU

130359920 2/27/2010 Admit ICU Floor Exit-Alive

130383532 2/25/2010 Admit ICU Floor Exit-Dead

130413669 3/1/2010 Admit ICU Floor

130643505 3/22/2010 Admit ICU Floor

24115024 Admit Emergency

Comparing Target: - (above) with - (below)

0 3D 6D 9D 12D 15D 18D 21D 24D 27D 1M 3D 6D 9D 12D 15D 18D 21D 24D 27D 2M 3D 6D 9D 12D 15D 18D

Search Filters Weight



Align by Admit

Similarity Search

- Select Target (Drag and Drop)  
Custom
- Select Categories
  - Include in Search
  - Visible
  - Admit (309)
  - Emergency (259)
  - ICU (338)
  - Intermediate (50)
  - Floor (406)
  - Exit-Alive (202)
- Choose time difference precision  
hour
- Specify Range of Interest (optional)  
[None]

Search !

“Similan”  
Copyright 2008-2009  
HCIL, University of Maryland

# Similan – Search by Similarity



Similan - /Volumes/DATADISK/Documents/FlexWorkspace/Similan/bin-debug/data/A\_Demo\_Proposal/ICU\_2... Showing 309 / 309 records

File Edit Settings Help

\*Target edit 0 1D 2D 3D 4D 5D 6D 7D 8D 9D 10D 11D 12D

Custom Admit Floor ICU

Search Filters Weight

Align by Admit

Similarity Search

\*Target edit 0 1D 2D 3D 4D 5D 6D 7D 8D 9D 10D 11D 12D

Custom Admit Floor ICU

2/25/2010 Floor Exit-Dead

130413669 3/1/2010 Admit ICU Floor

130643505 3/22/2010 Admit ICU Floor

24115024 Admit Emergency

Intermedia Floor Exit-Alive Del

Reset Done

Emergency (259) ICU (338) Intermediate (50) Floor (406) Exit-Alive (202)

3. Choose time difference precision hour

4. Specify Range of Interest (optional) [None]

Search !

Comparing Target: - (above) with - (below)

0 3D 6D 9D 12D 15D 18D 21D 24D 27D 1M 3D 6D 9D 12D 15D 18D 21D 24D 27D 2M 3D 6D 9D 12D 15D 18D

HCIL "Similan" Copyright 2008-2009 HCIL, University of Maryland

Similan – Search by Similarity

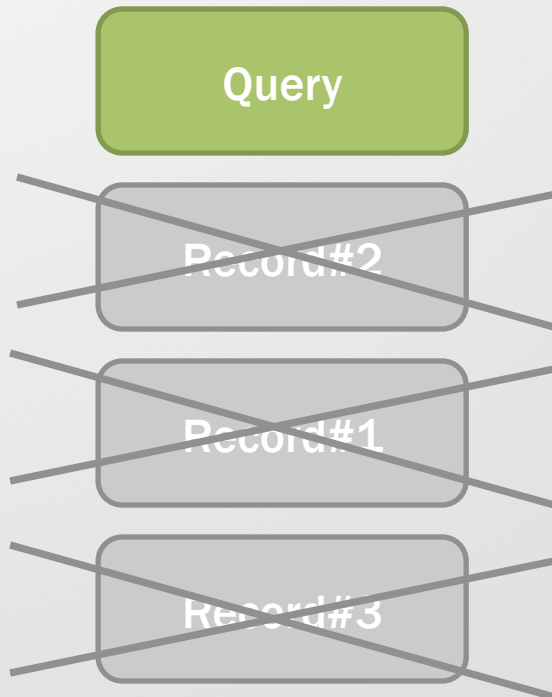


# USER STUDIES: SEARCH

## LIFELINES2

*Exact*

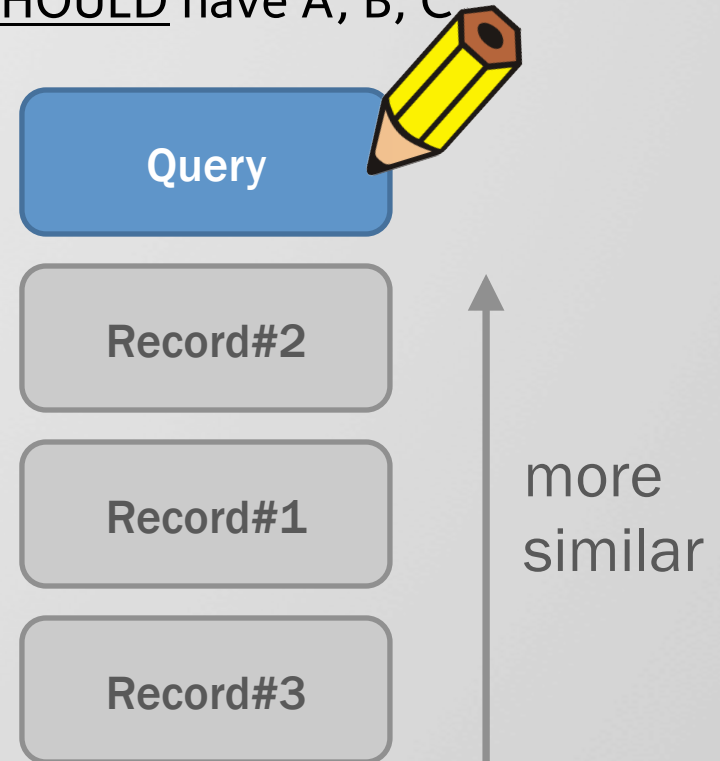
MUST have A, B, C



## SIMILAN

*Similarity-based*

SHOULD have A, B, C

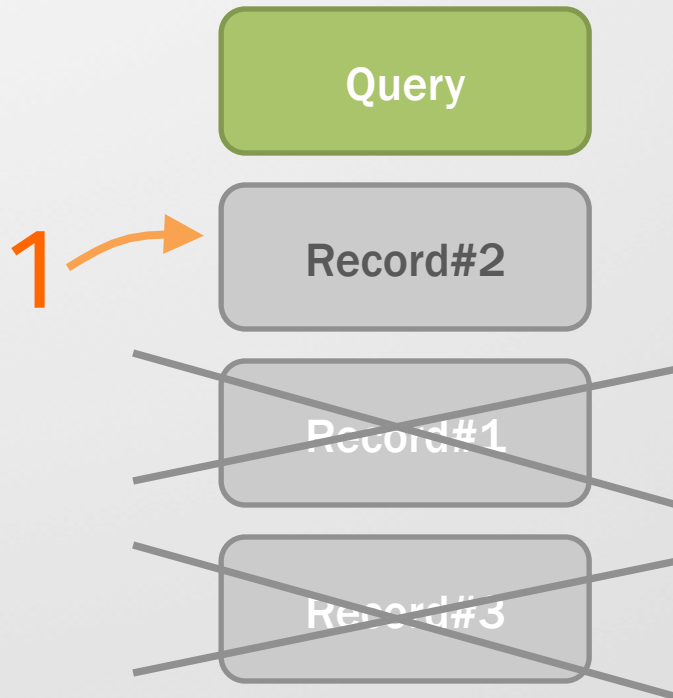


# USER STUDIES: SEARCH

## LIFELINES2

*Exact*

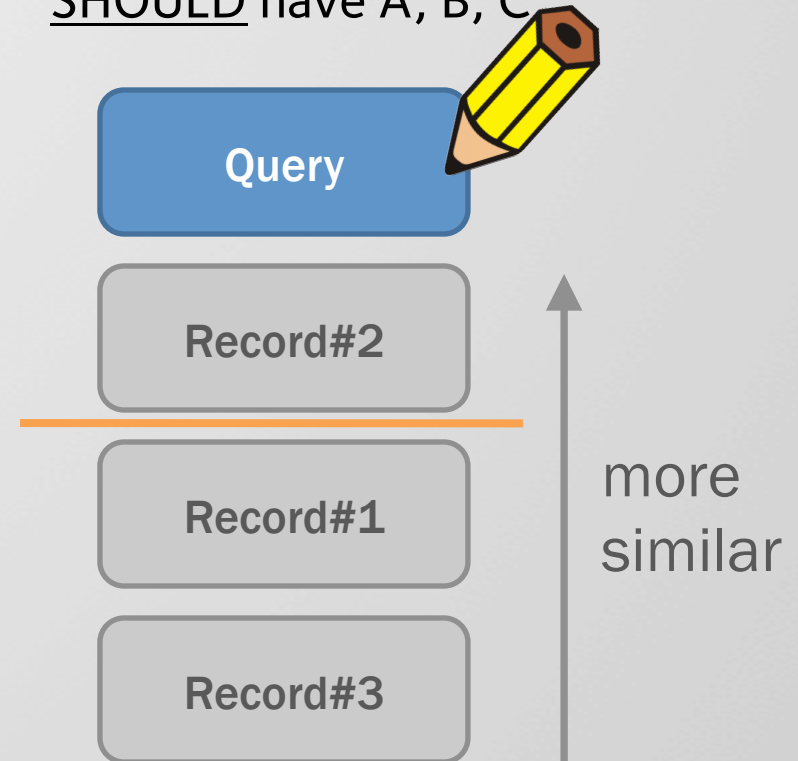
MUST have A, B, C



## SIMILAN

*Similarity-based*

SHOULD have A, B, C



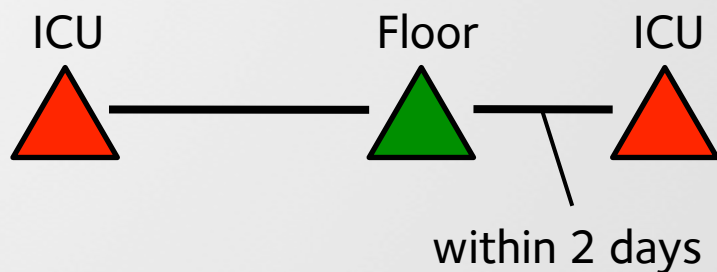
# NEW STUFF

*Needs for an overview -> LifeFlow!*

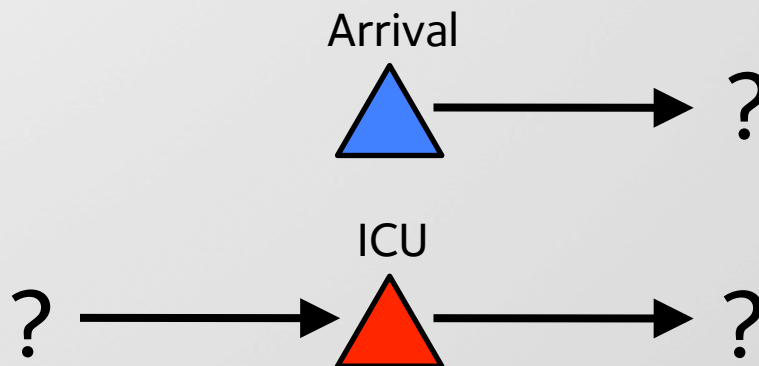


# TASKS

- Example: Finding “Bounce backs”



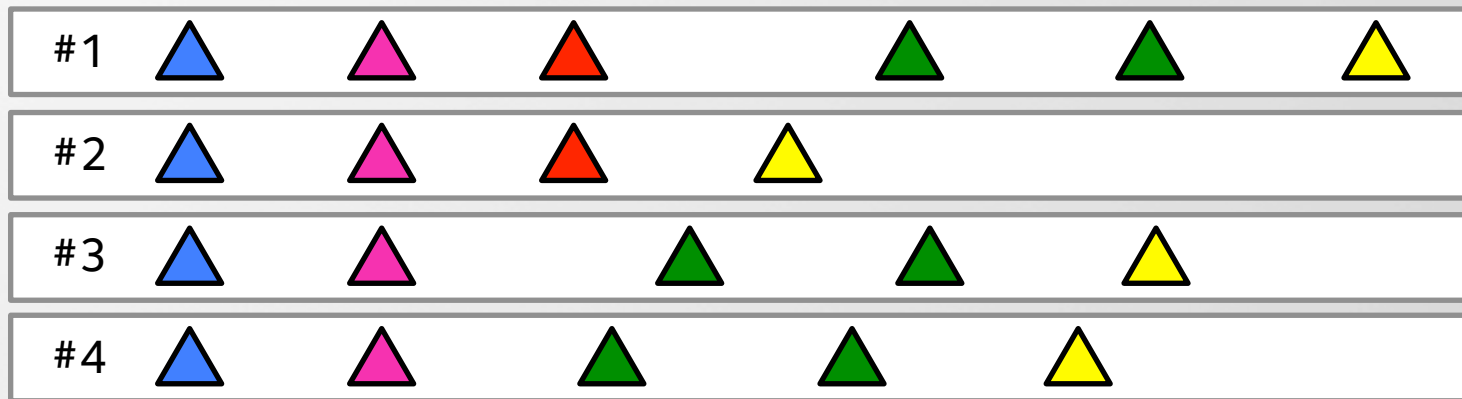
- Other questions





# AGGREGATE

- Aggregate by prefix

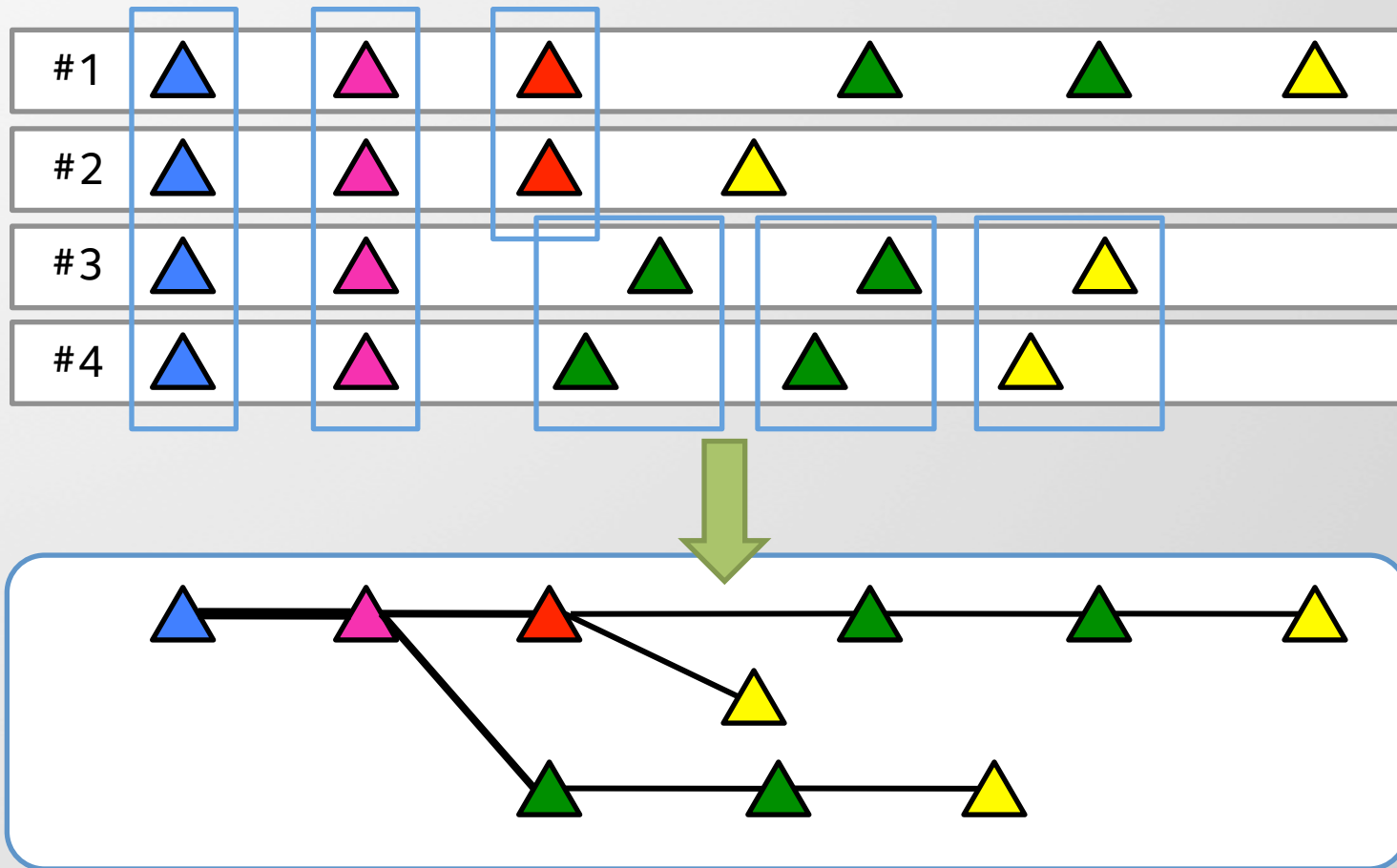


Example with 4 records



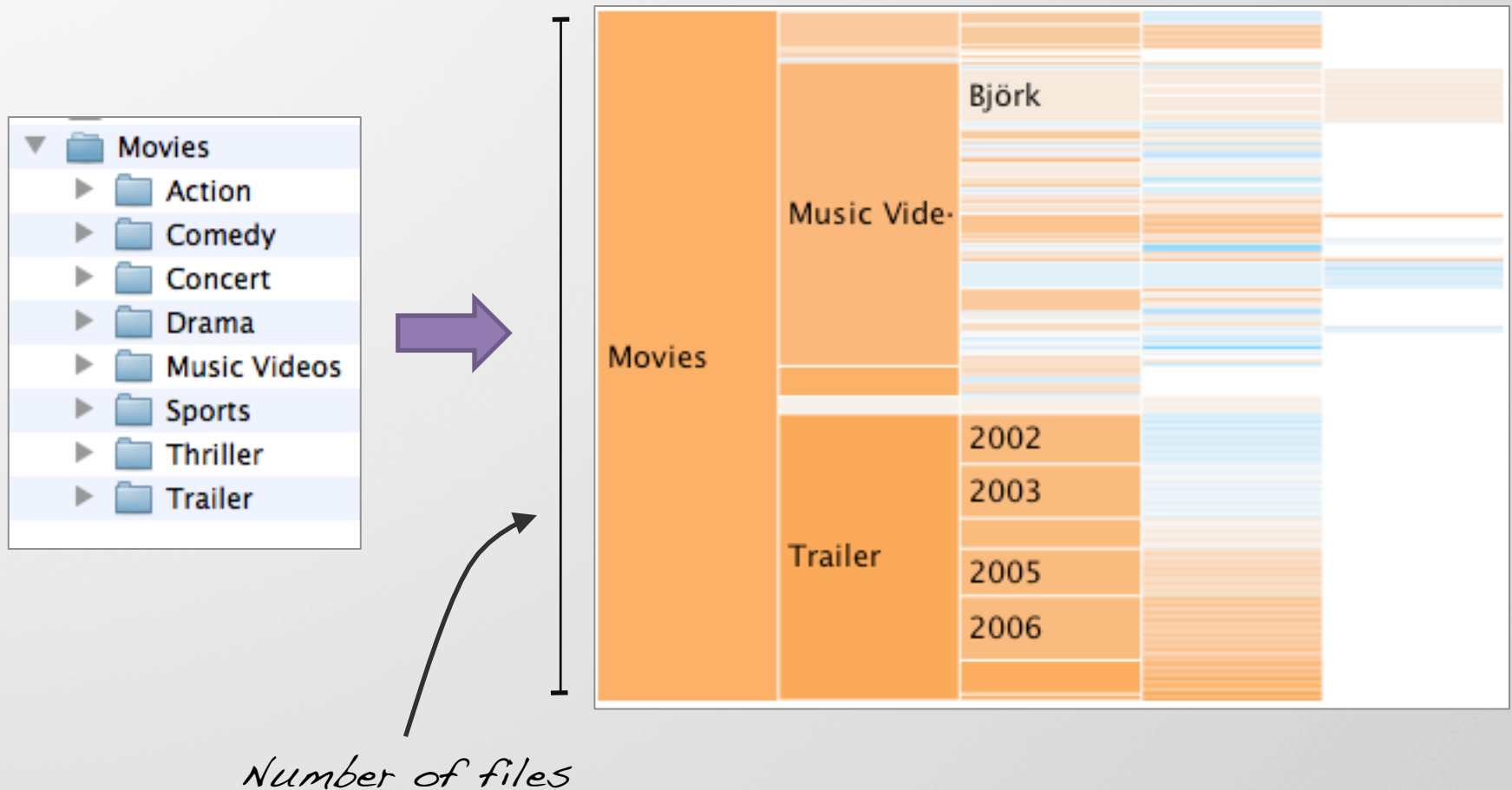
# AGGREGATE

- Aggregate by prefix



# VISUALIZE

- Inspired by the Icicle tree [Fekete 2004]



# VISUALIZE (2)

- Use horizontal axis to represent time
- Video

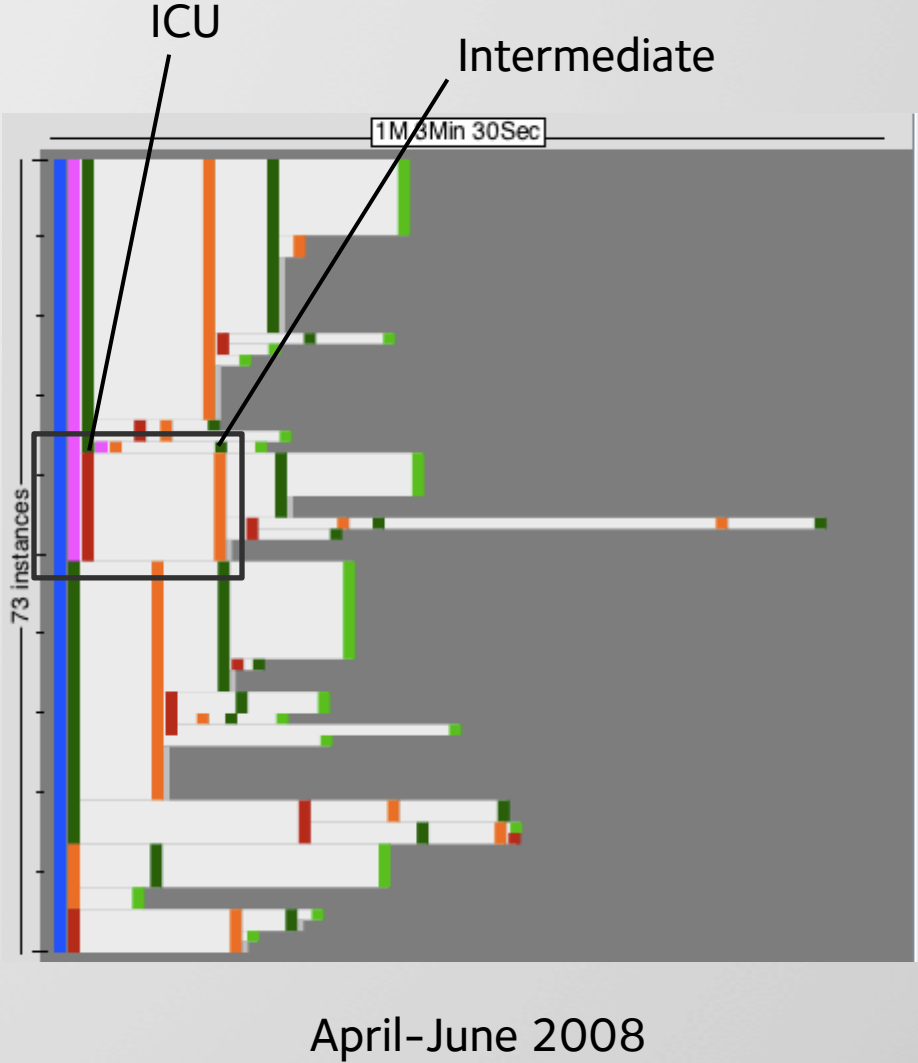
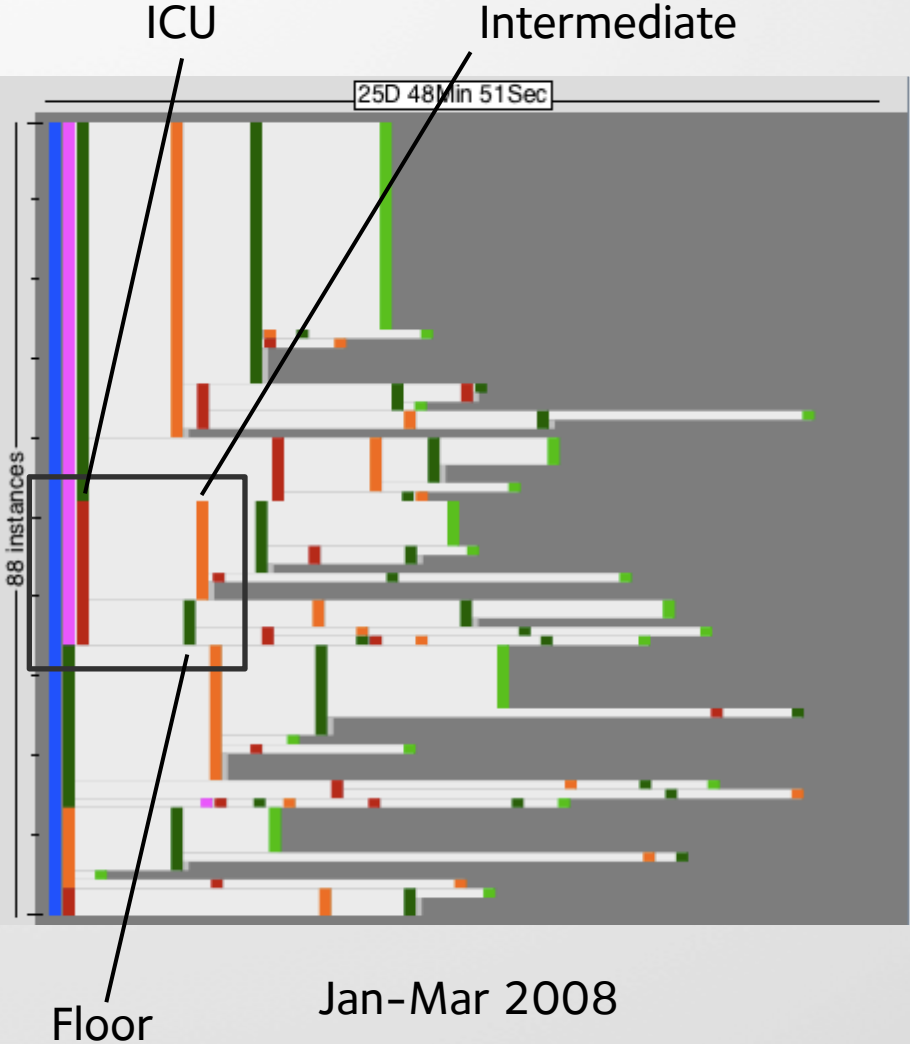
# DEMO – LIFEFLOW

*When the lines are combined into flow*



# FUTURE WORK

- Comparison



# TAKE-AWAY MESSAGE

INFORMATION VISUALIZATION IS A POWERFUL WAY TO EXPLORE TEMPORAL PATTERNS.

YOU CAN WORK WITH US ON NEW CASE STUDIES.

