

# More on Time



CS 4460 - Information Visualization  
Jim Foley

Some PPts from Prof. John Stasko.

Last revision: October 2016

# A Taxonomy of Time Data

- Continuous – a series of values that change over time

- Non-periodic
  - Periodic

- Discrete – an event that occurs at a specific time

- Non-periodic (non-recurring)
  - Periodic

- More on next pages.....

Time	Value
10:00	57
10:01	62
10:02	60
10:03	60
Etc	etc

Time	Event
20 July 1957	John born
5 Sept. 1973	John graduates HS

# Time Series Examples

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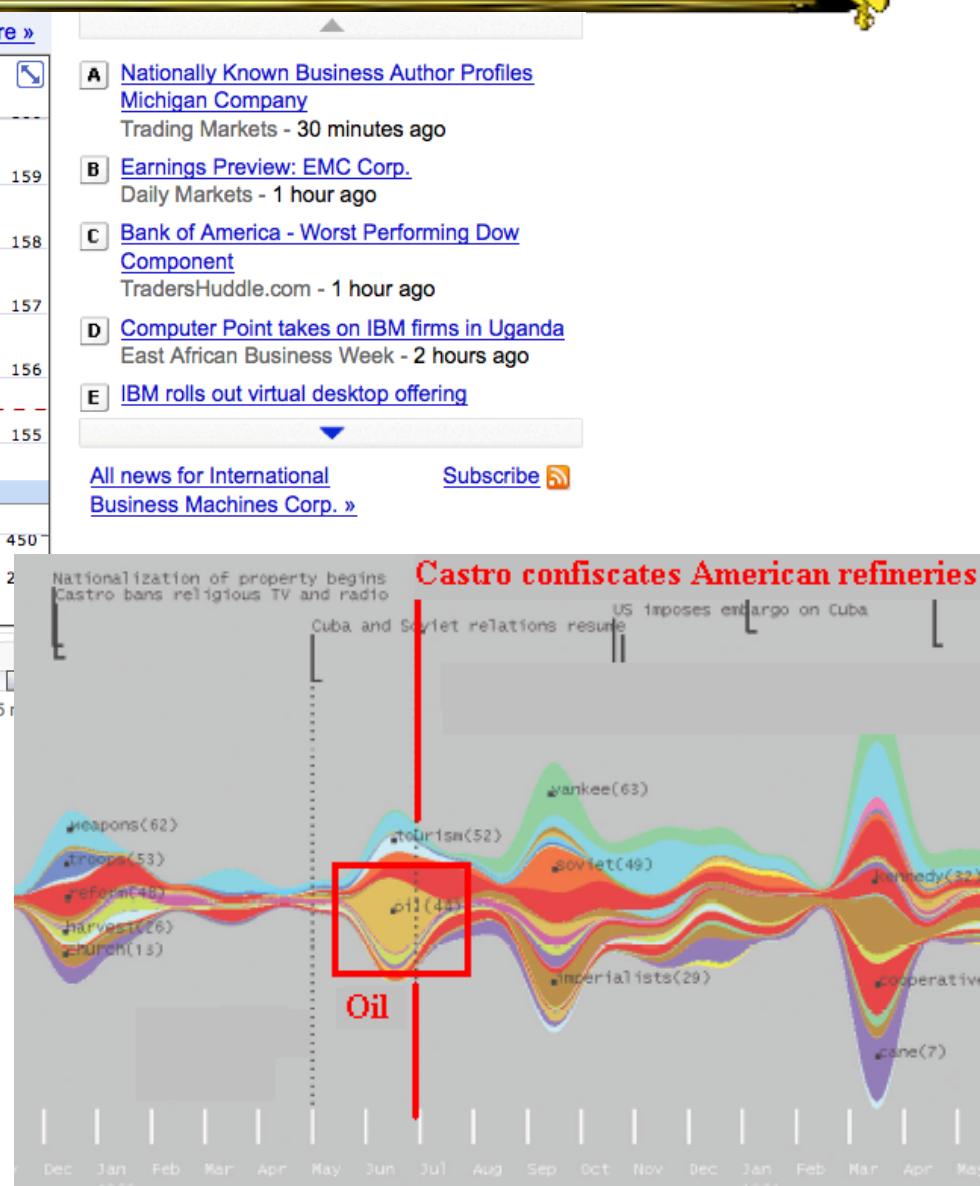


- As we step through examples, answer these questions about each example
  - What are similarities?
  - Differences?
  - When is each useful?
  - Pros/cons of each?
    - How much info is visually coded?
    - Scalable to more events & longer time scale / intervals?
    - How good for comparing multiple time series?

# Examples



<https://eresearch.fidelity.com/eresearch/evaluate/snapshot.jhtml?symbol=AAPL>



# Discuss

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- What type of time data shown?
- When useful?
- How much info is visually coded?
- Scalable to more events & longer time scale / intervals?
- How good for comparing multiple time series?

# Example: Finding Daily Patterns

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- Suppose you have a daily log, for a year, of energy consumption in a building, or number of people in building
  - Want to find common characteristics
  - Idea applies beyond this example

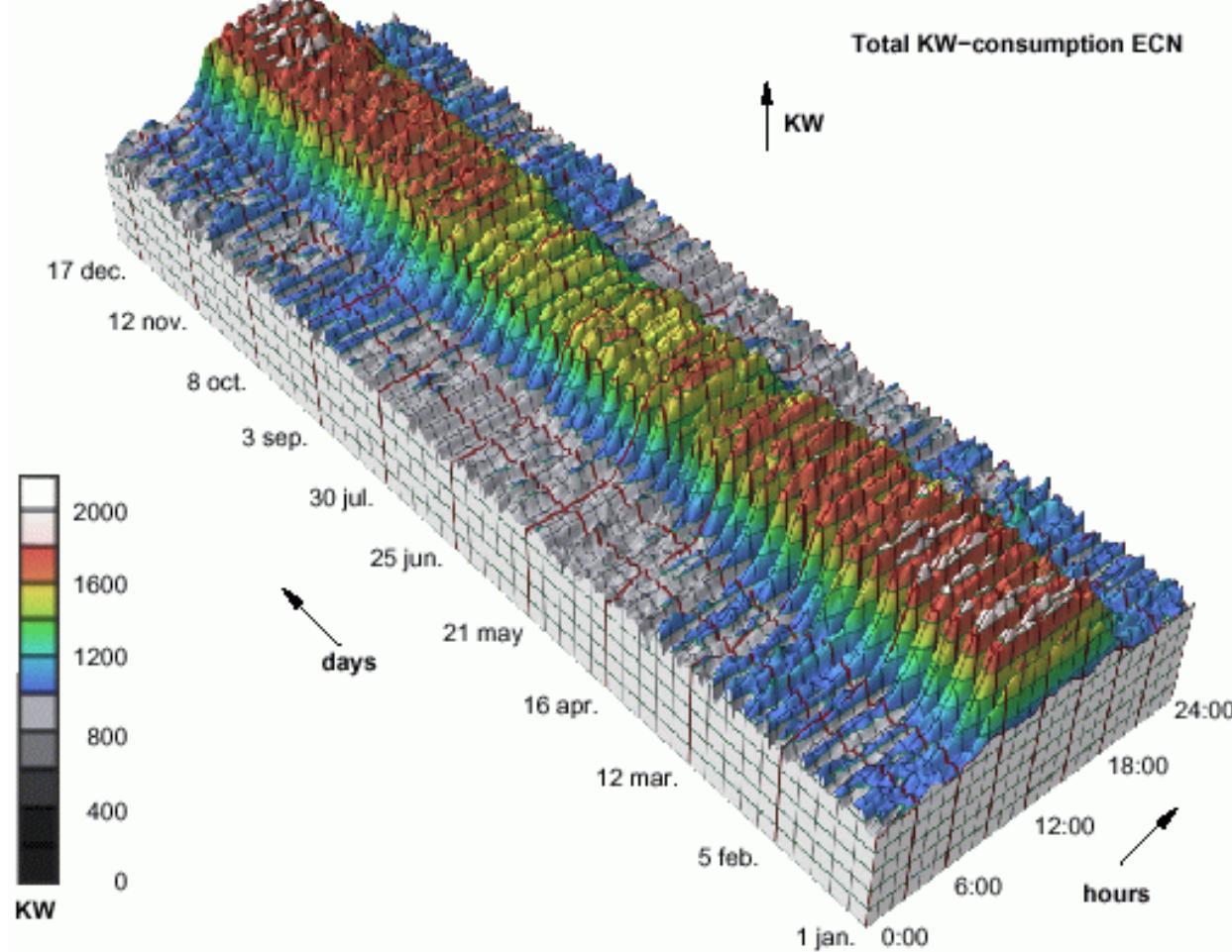
Wijk and Selow, *Cluster and Calendar based Visualization of Time Series Data*, InfoVis '99

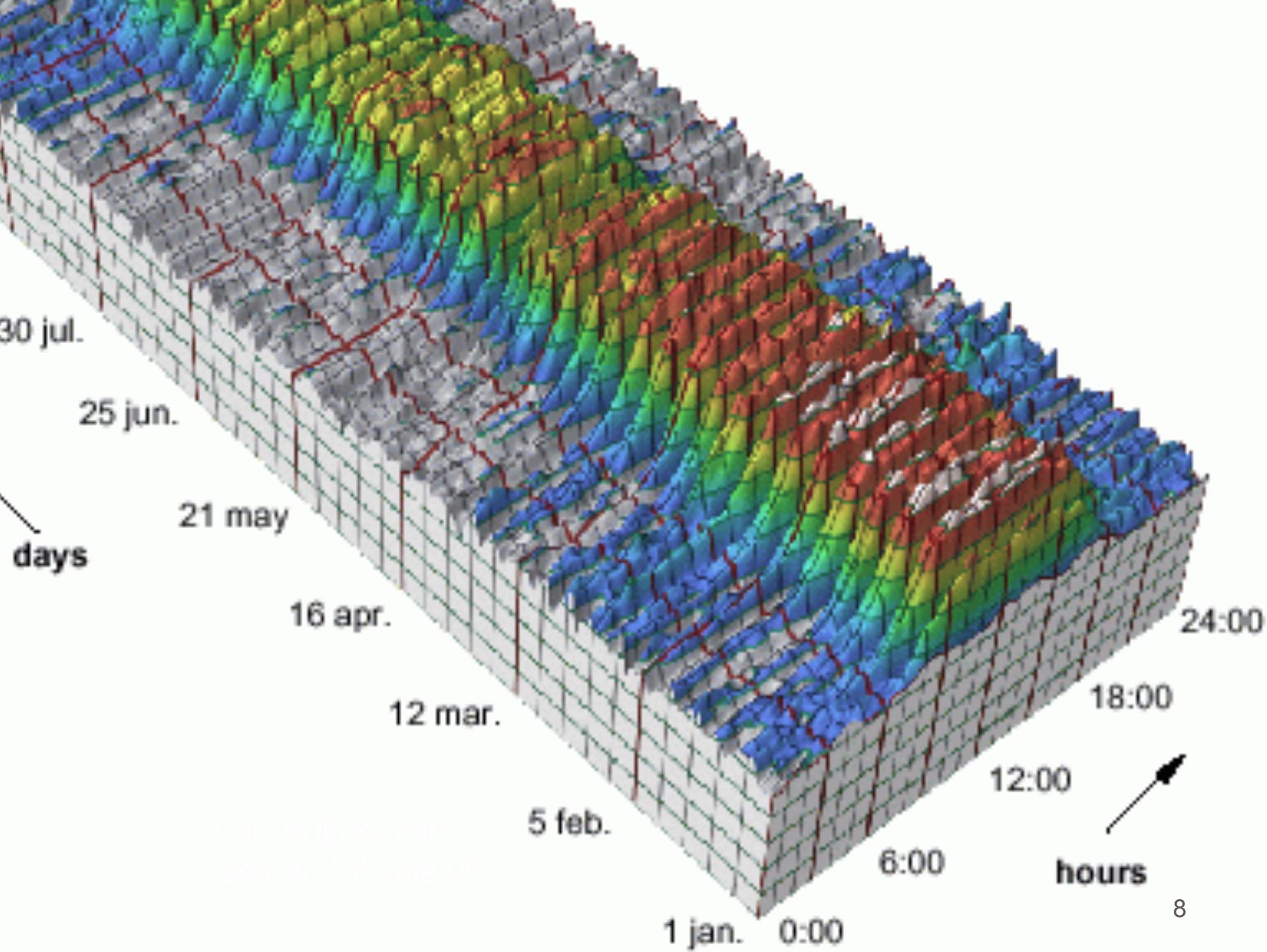
# Raw Data



- Ideas?

See larger view  
of data on  
next slide





# Discuss

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- What type of time data shown?
- When useful?
- How much info is visually coded?
- Scalable to more events & longer time scale / intervals?
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# Use ‘Cluster Analysis’

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- Start with the  $n$  days, call each a cluster
- Find two most similar clusters
- Combine the two into one cluster
- Now have  $n-1$  clusters
- Repeat until some preset number left or a condition is met
- How can results be visualized?

# An Aside – Cluster Analysis

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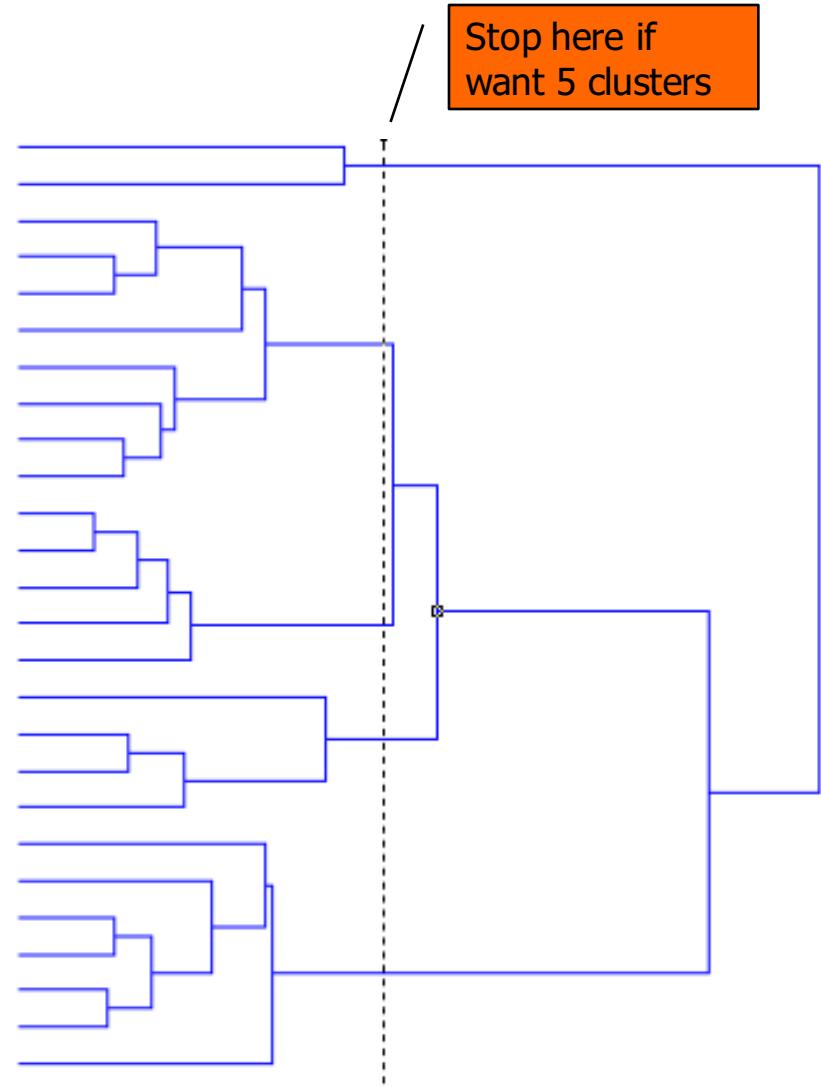


- Widely-used method
  - Defining ‘close’ is key
    - Varies from one domain to another
    - Text - count differences – key words, tags
    - Pictures
    - Time-varying data
    - $\sum |\Delta_i|$ ,  $i$  varies over sample length, such as 24 hour period in previous example or over key word count for text
- Why use absolute value of  $\Delta_i$  ?

# An Aside - Dendogram



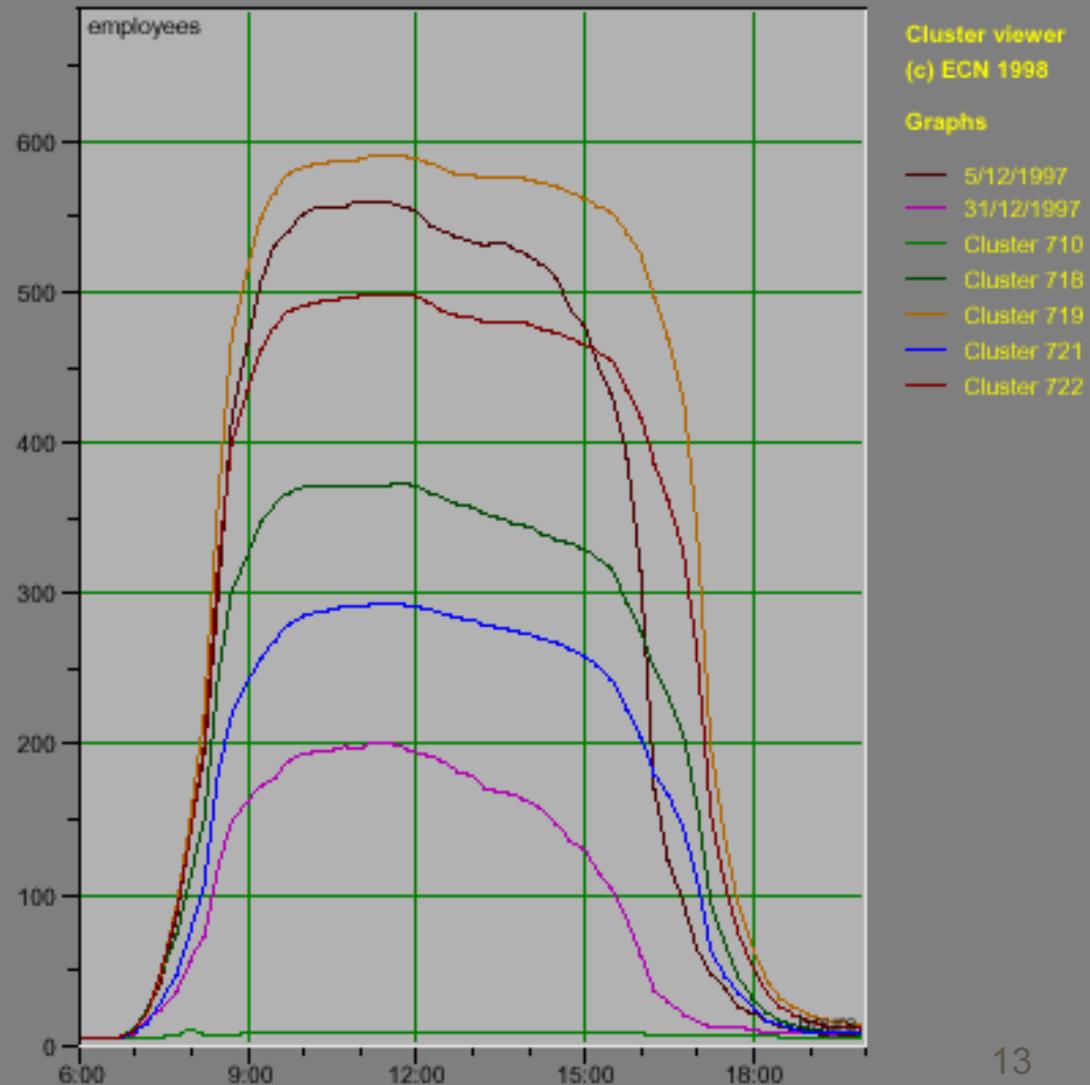
- Dendrogram – tree that results from clustering
  - Can show process until is a single cluster
  - Stop clustering when have as few as desired



# Cluster Display – People at Work



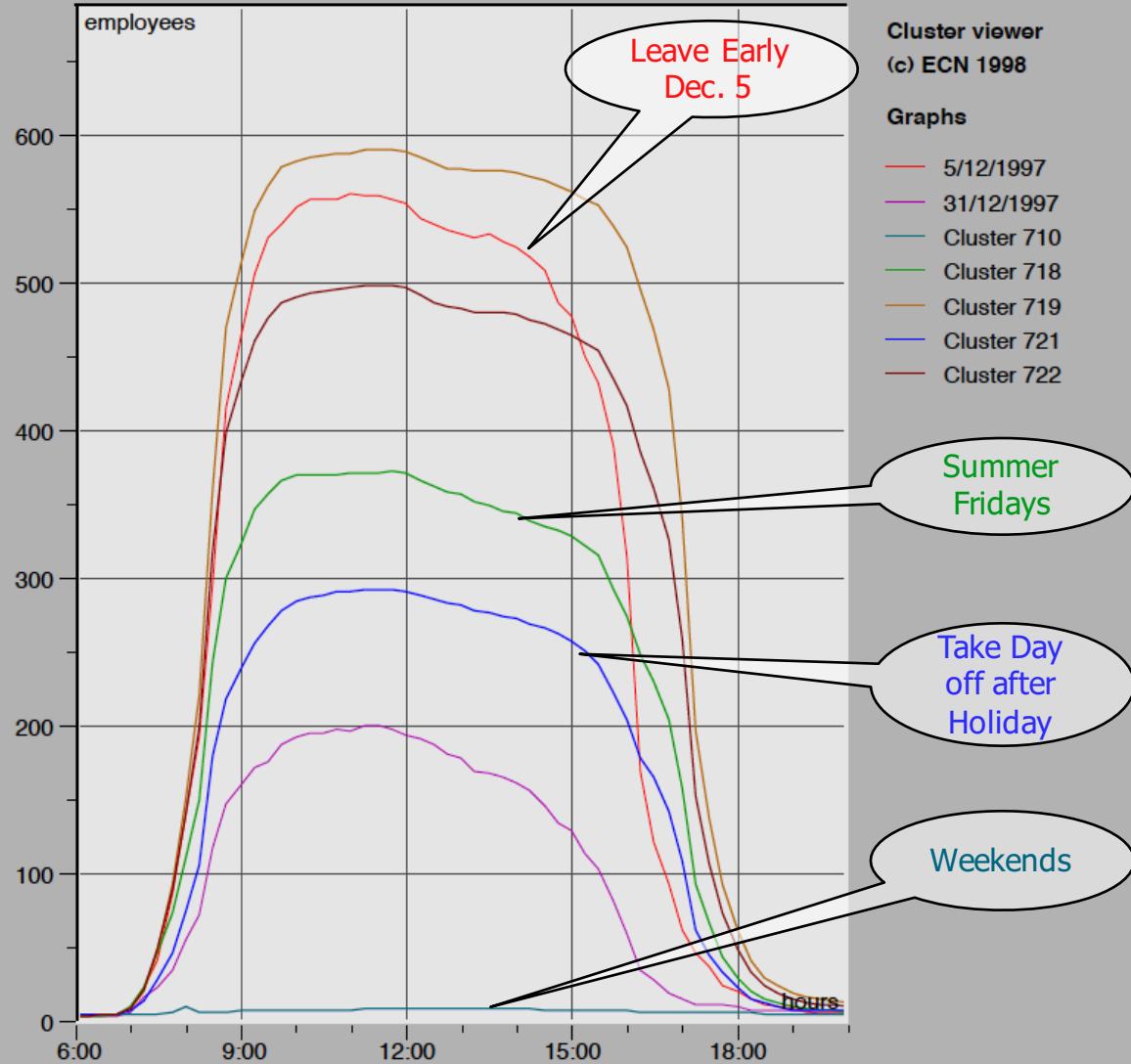
	1997											
	januari				februari				maart			
ma	6	13	20	27	3	10	17	24	3	10	17	24
di	7	14	21	28	4	11	18	25	4	11	18	25
wo	1	8	15	22	29	5	12	19	26	5	12	19
do	2	9	16	23	30	6	13	20	27	6	13	20
vr	3	10	17	24	31	7	14	21	28	7	14	21
za	4	11	18	25	1	8	15	22	1	8	15	22
zo	5	12	19	26	2	9	16	23	2	9	16	23
	april				mei				juni			
ma	7	14	21	28	5	12	19	26	2	9	16	23
di	1	8	15	22	29	6	13	20	27	3	10	17
wo	2	9	16	23	30	7	14	21	28	4	11	18
do	3	10	17	24	1	8	15	22	5	12	19	26
vr	4	11	18	25	2	9	16	23	6	13	20	27
za	5	12	19	26	3	10	17	24	7	14	21	28
zo	6	13	20	27	4	11	18	25	1	8	15	22
	juli				augustus				september			
ma	7	14	21	28	4	11	18	25	1	8	15	22
di	1	8	15	22	29	5	12	19	2	9	16	23
wo	2	9	16	23	30	6	13	20	24	3	10	17
do	3	10	17	24	31	7	14	21	28	4	11	18
vr	4	11	18	25	1	8	15	22	5	12	19	26
za	5	12	19	26	2	9	16	23	6	13	20	27
zo	6	13	20	27	3	10	17	24	7	14	21	28
	oktober				november				december			
ma	6	13	20	27	3	10	17	24	1	8	15	22
di	7	14	21	28	4	11	18	25	2	9	16	23
wo	1	8	15	22	29	5	12	19	3	10	17	24
do	2	9	16	23	30	6	13	20	27	4	11	18
vr	3	10	17	24	31	7	14	21	28	5	12	19
za	4	11	18	25	1	8	15	22	6	13	20	27
zo	5	12	19	26	2	9	16	23	7	14	21	28



# Cluster Display – People at Work



1997						
	januari	februari	maart	april	mei	juni
ma	6 13 20 27	3 10 17 24	3 10 17 24 31	7 14 21 28	5 12 19 26	2 9 16 23 30
di	7 14 21 28	4 11 18 25	4 11 18 25	8 15 22 29	6 13 20 27	3 10 17 24
wo	1 8 15 22 29	5 12 19 26	5 12 19 26	9 16 23 30	7 14 21 28	4 11 18 25
do	2 9 16 23 30	6 13 20 27	6 13 20 27	10 17 24 31	8 15 22 29	5 12 19 26
vr	3 10 17 24 31	7 14 21 28	7 14 21 28	1 8 15 22 29	1 8 15 22 29	6 13 20 27
za	4 11 18 25	2 9 16 23 30	2 9 16 23 30	5 12 19 26	4 11 18 25	7 14 21 28
zo	5 12 19 26			6 13 20 27		
oktober						
ma	6 13 20 27	3 10 17 24	1 8 15 22 29	7 14 21 28	4 11 18 25	2 9 16 23 30
di	7 14 21 28	4 11 18 25	2 9 16 23 30	8 15 22 29	5 12 19 26	6 13 20 27
wo	1 8 15 22 29	5 12 19 26	3 10 17 24	9 16 23 30	7 14 21 28	4 11 18 25
do	2 9 16 23 30	6 13 20 27	7 14 21 28	10 17 24 31	8 15 22 29	5 12 19 26
vr	3 10 17 24 31	7 14 21 28	7 14 21 28	1 8 15 22 29	1 8 15 22 29	6 13 20 27
za	4 11 18 25	2 9 16 23 30	2 9 16 23 30	5 12 19 26	4 11 18 25	7 14 21 28
zo	5 12 19 26	1 8 15 22 29	1 8 15 22 29	6 13 20 27	5 12 19 26	7 14 21 28
november						
ma	6 13 20 27	1 8 15 22 29	1 8 15 22 29	7 14 21 28	3 10 17 24	2 9 16 23 30
di	7 14 21 28	4 11 18 25	2 9 16 23 30	8 15 22 29	4 11 18 25	3 10 17 24
wo	1 8 15 22 29	5 12 19 26	3 10 17 24	9 16 23 30	5 12 19 26	4 11 18 25
do	2 9 16 23 30	6 13 20 27	7 14 21 28	10 17 24 31	6 13 20 27	5 12 19 26
vr	3 10 17 24 31	7 14 21 28	7 14 21 28	1 8 15 22 29	5 12 19 26	6 13 20 27
za	4 11 18 25	2 9 16 23 30	2 9 16 23 30	5 12 19 26	4 11 18 25	7 14 21 28
zo	5 12 19 26	1 8 15 22 29	1 8 15 22 29	6 13 20 27	5 12 19 26	7 14 21 28
december						
ma	6 13 20 27	1 8 15 22 29	1 8 15 22 29	7 14 21 28	3 10 17 24	2 9 16 23 30
di	7 14 21 28	4 11 18 25	2 9 16 23 30	8 15 22 29	4 11 18 25	3 10 17 24
wo	1 8 15 22 29	5 12 19 26	3 10 17 24	9 16 23 30	5 12 19 26	4 11 18 25
do	2 9 16 23 30	6 13 20 27	7 14 21 28	10 17 24 31	6 13 20 27	5 12 19 26
vr	3 10 17 24 31	7 14 21 28	7 14 21 28	1 8 15 22 29	5 12 19 26	6 13 20 27
za	4 11 18 25	2 9 16 23 30	2 9 16 23 30	5 12 19 26	4 11 18 25	7 14 21 28
zo	5 12 19 26	1 8 15 22 29	1 8 15 22 29	6 13 20 27	5 12 19 26	7 14 21 28



# What Cluster Display Shows Us

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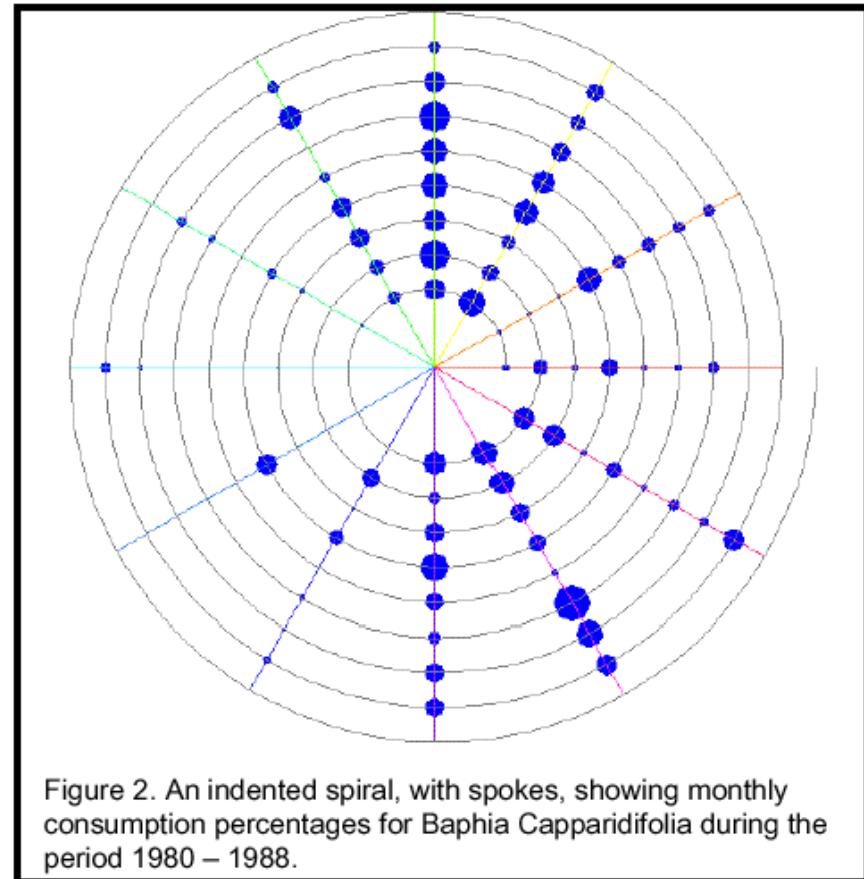


- Traditional office hours followed
- Most are present late mornings
- Fewer are present on summer Fridays
- Very few people work holidays
- School vacations
- Day after holidays
- Many people leave at 4PM on 12/5
  - Very special in The Netherlands – St. Nicholas' Eve

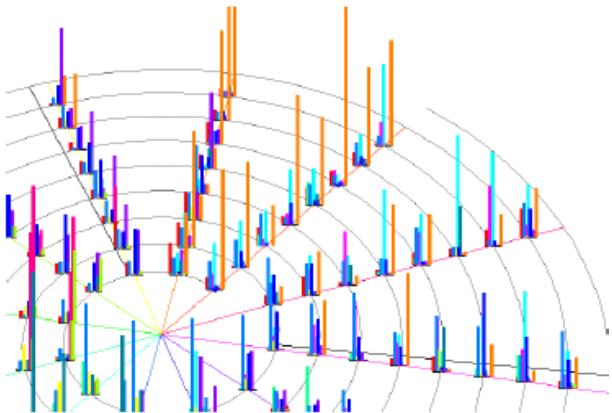
# Example: Spiral Display - Periodic Data



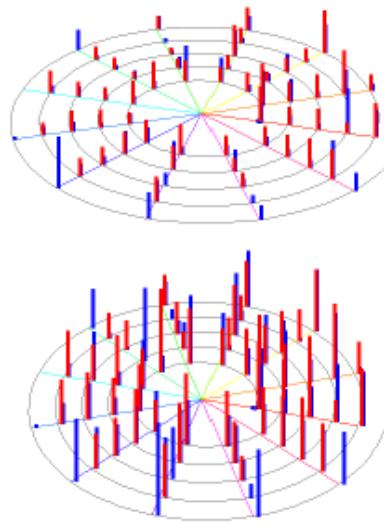
- Useful if data follows a repetitive pattern
- Can reveal periodicity
  - One loop is one period
  - What if data NOT periodic?
- Time line becomes the spiral
  - Avoid problem of long time line
  - *Could use concentric circles instead of spiral*



# Add Third Dimension for More Data



Mini bar-chart at each point  
Black line – start of rainy  
season



Two linked  
spirals:  
2 chimpanzees  
group avg size &  
max size



112 food types  
Useful? ☺

# Discuss

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- What type of time data shown?
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# Design Exercise

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- Data - for every hour of the day for an entire year
  - Number of road accidents in three different counties, plus total
- For each month, show aggregated accident counts for Sun, Mon, Tues etc, for each county & total
- Select date range and time of day range
- Now also show hour-by-hour accident count for each county & total, for the selected date/time ranges
  - (and possibly just for one day or the week during the selected date/time ranges)
- I have one design, looking for lots of creativity from y'all ☺

# Prostate Cancer Progression

Click in colored area to sort by event duration



Patient List

Click on triangle to align on event onset

Green: surgery  
Yellow: biochemical re-occurrence  
Red: metastasize  
Black (solid): death from cancer  
Black (dot): death not from cancer  
Spark lines: PSA level

CS4460

-144

-120

-96

-72

-48

-24

0

24

# Time in 2D

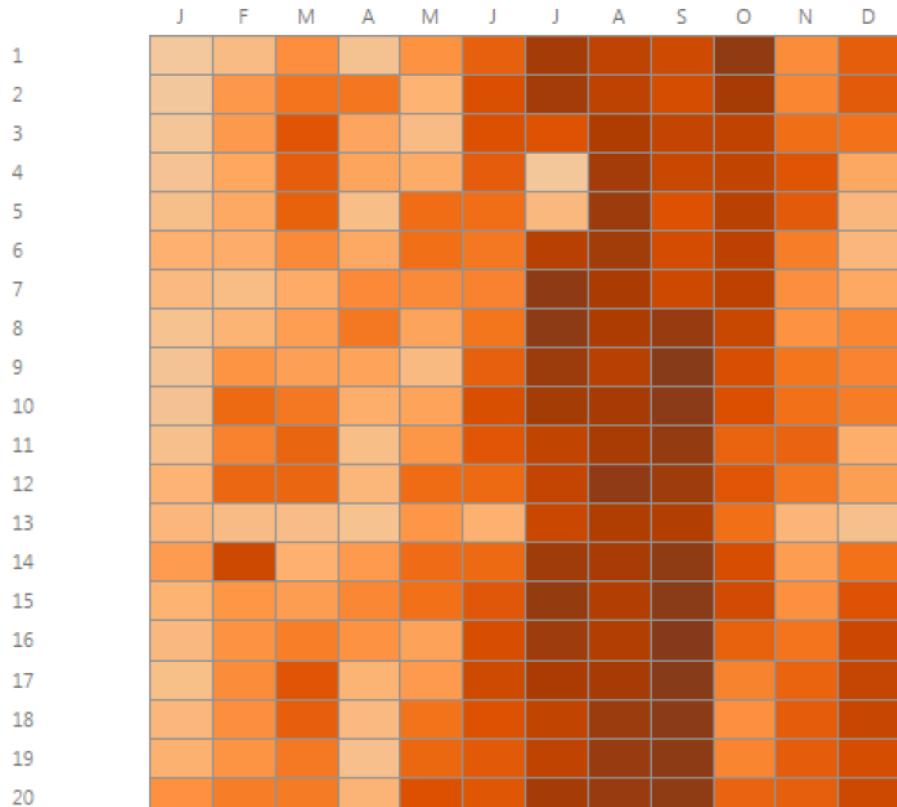


## How common is your birthday?

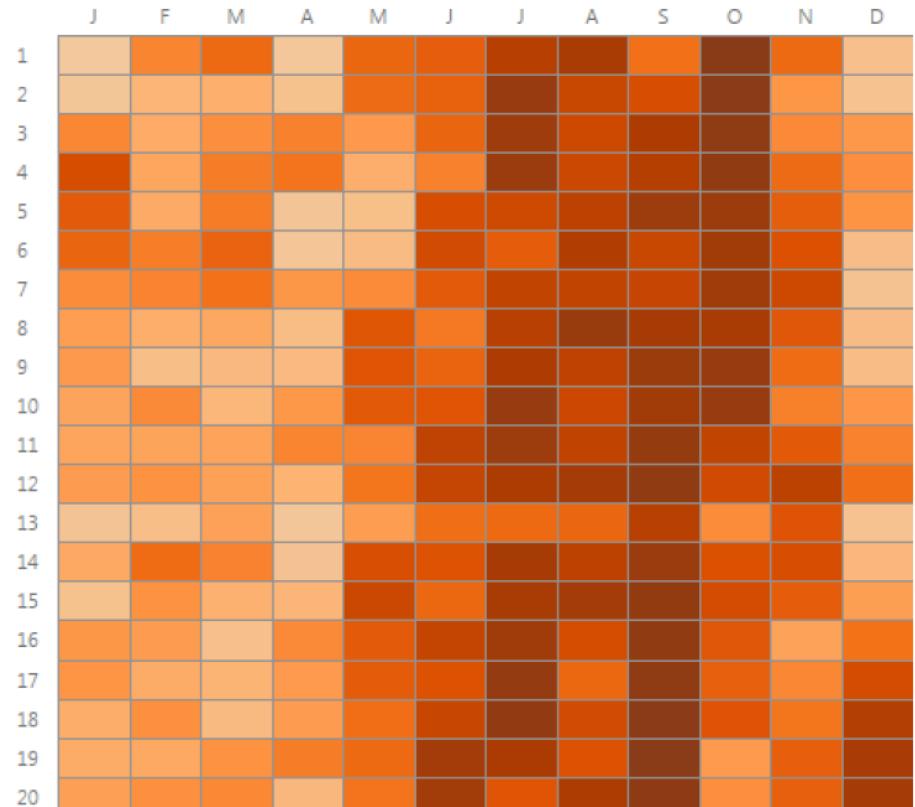
Two charts showing the most and least popular birthdays in the USA and England/Wales.  
The darker the colour, the more common that birthday is.



USA



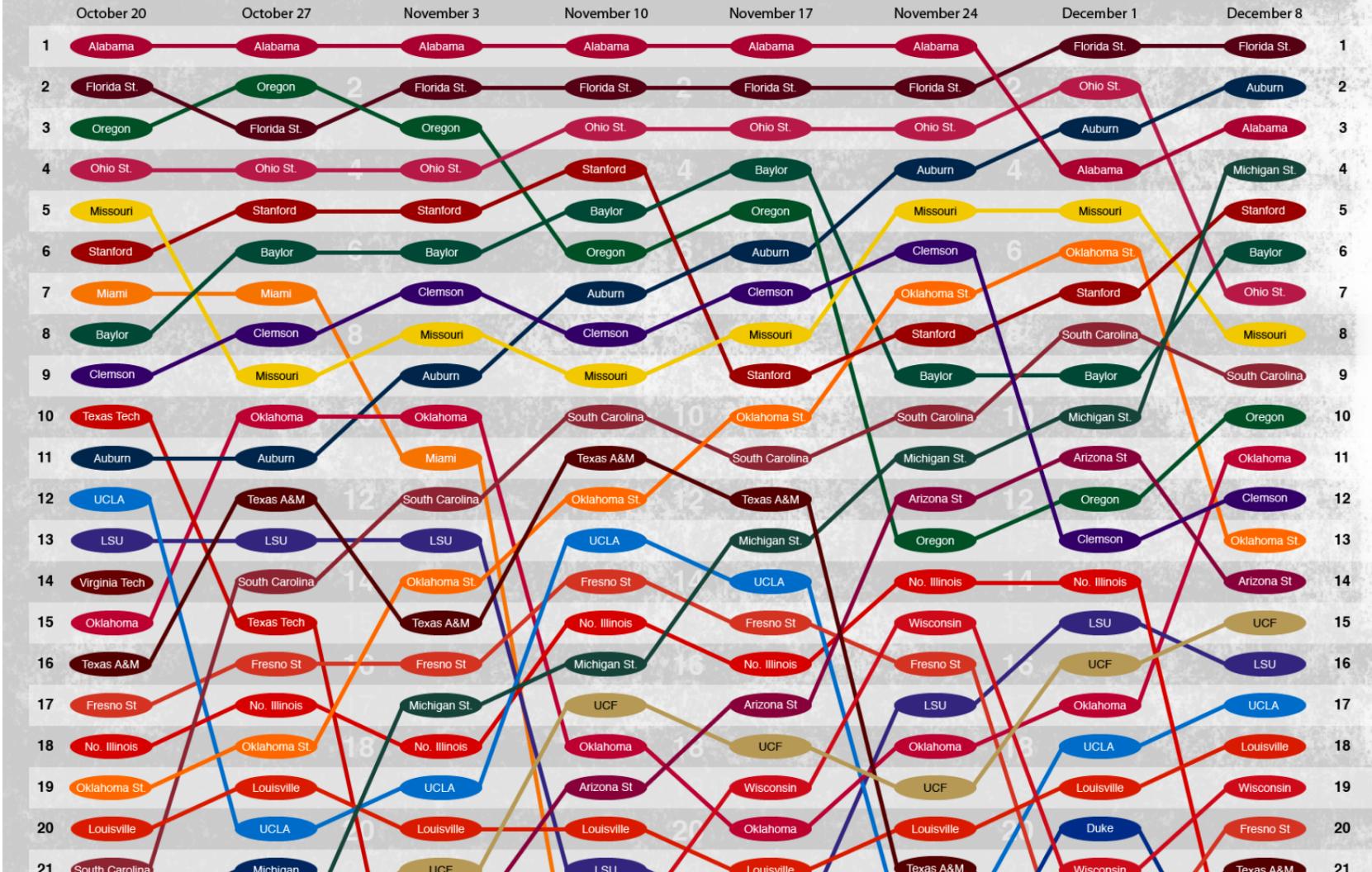
England and Wales



# Time via Parallel Coordinates



## 2013 BCS College Football Rankings

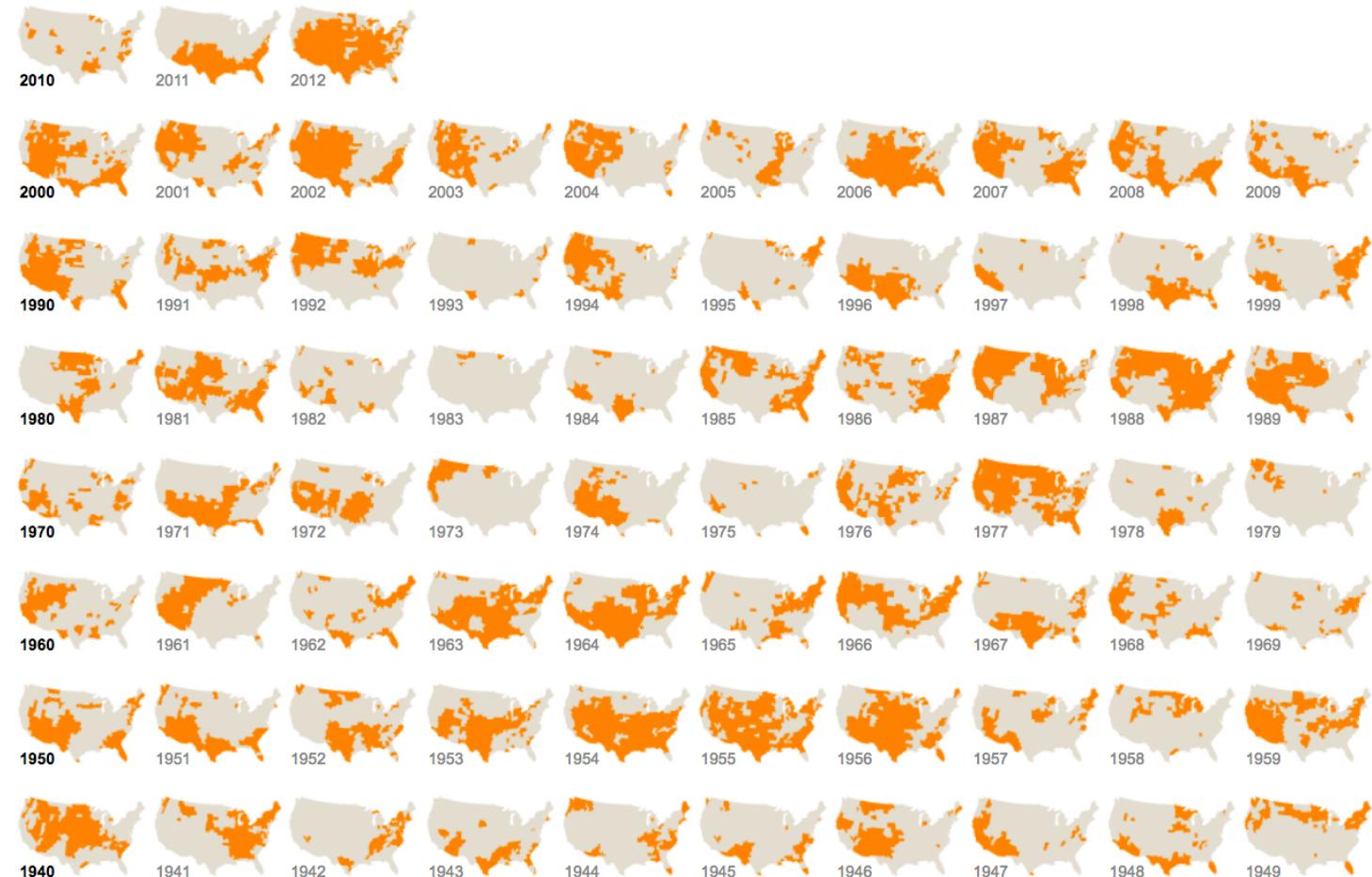


# Time via Small Multiples

## Drought's Footprint

More than half of the country was under moderate to extreme drought in June, the largest area of the contiguous United States affected by such dryness in nearly 60 years. Nearly 1,300 counties across 29 states have been declared federal disaster areas. Areas under moderate to extreme drought in June of each year are shown in orange below.

[Related Article »](#)

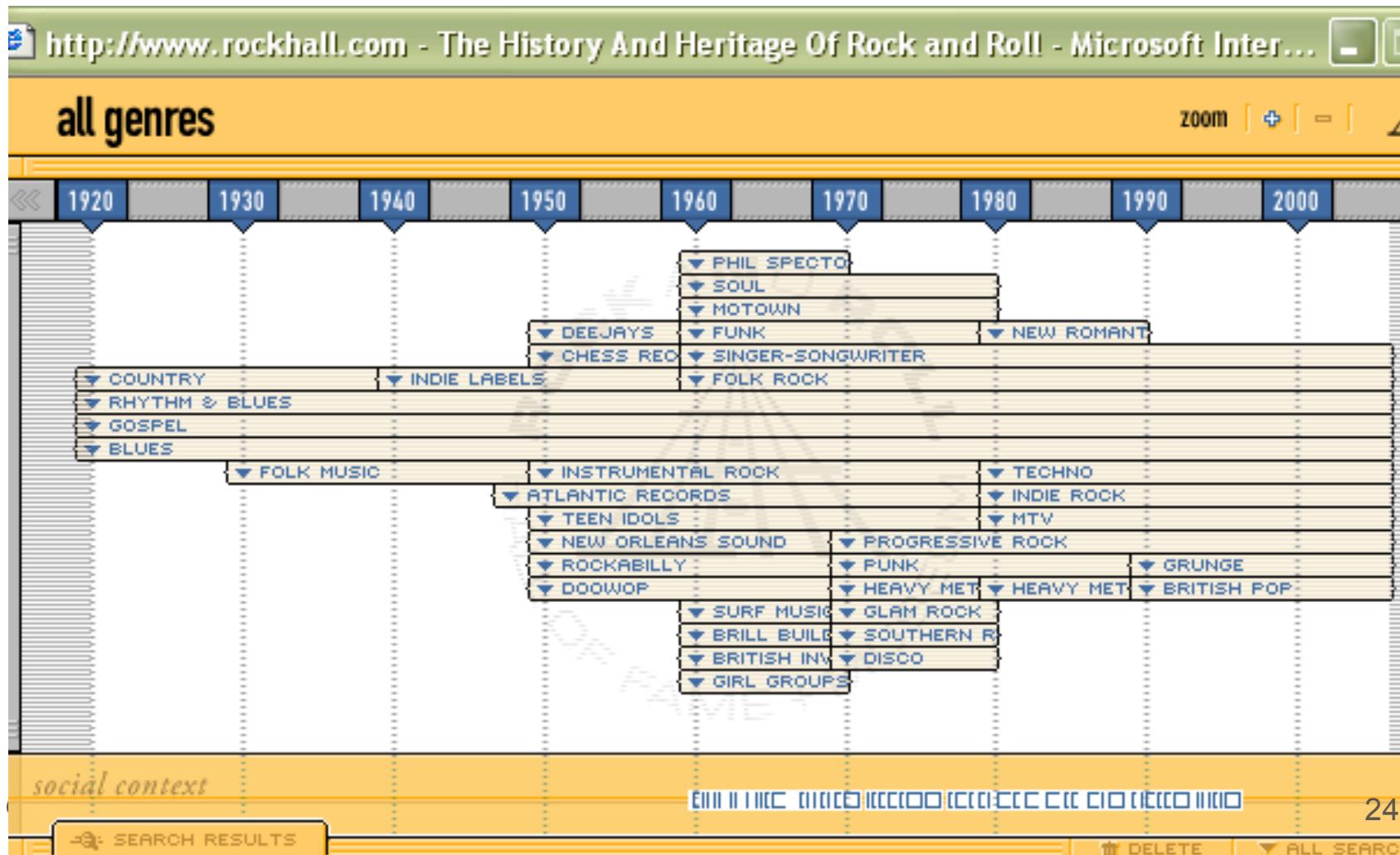


# Example: Music Over Time



## History of Genres

<http://rockhall.com/timeline/> (dead link)

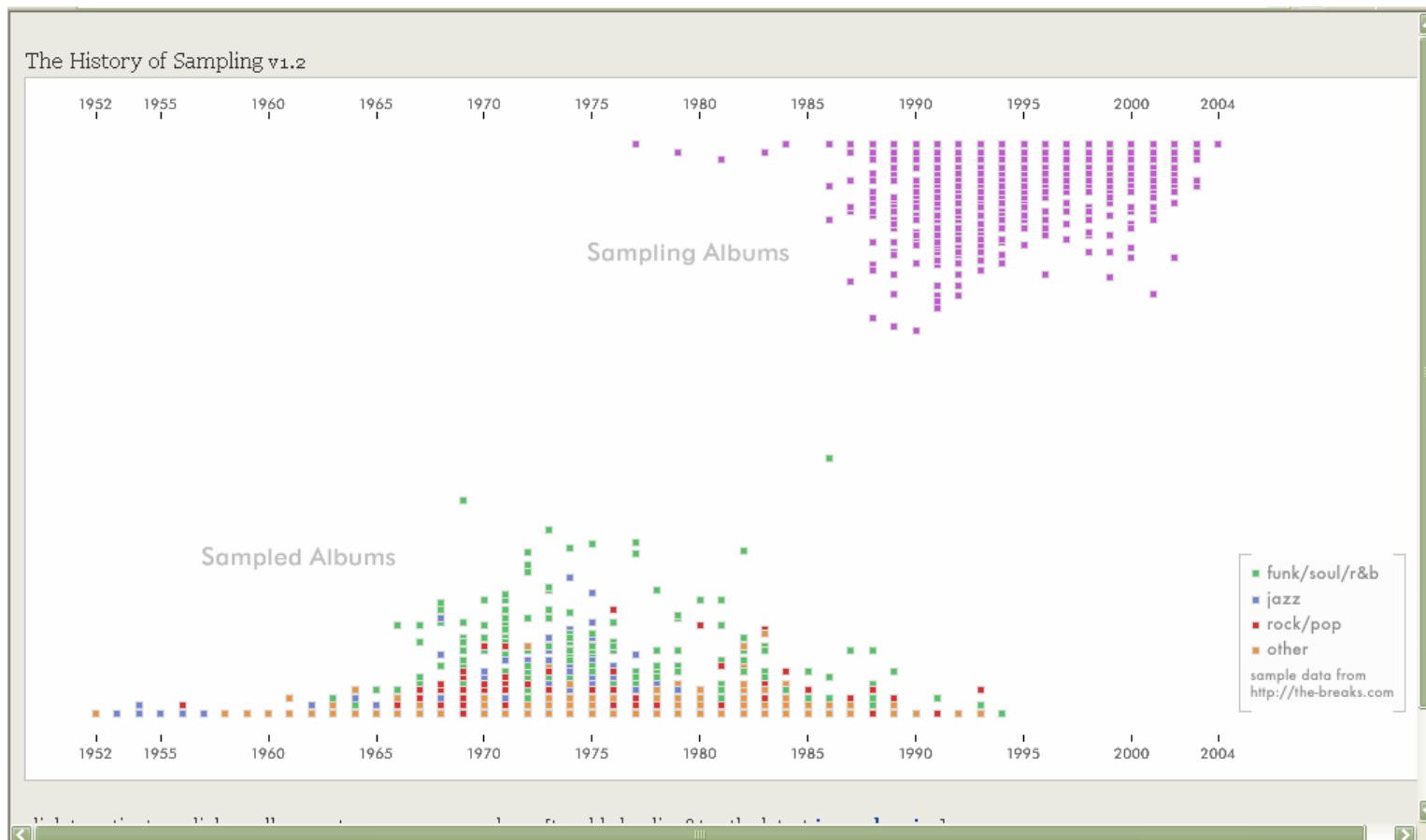


# Example: Music Over Time



## History of Sampling

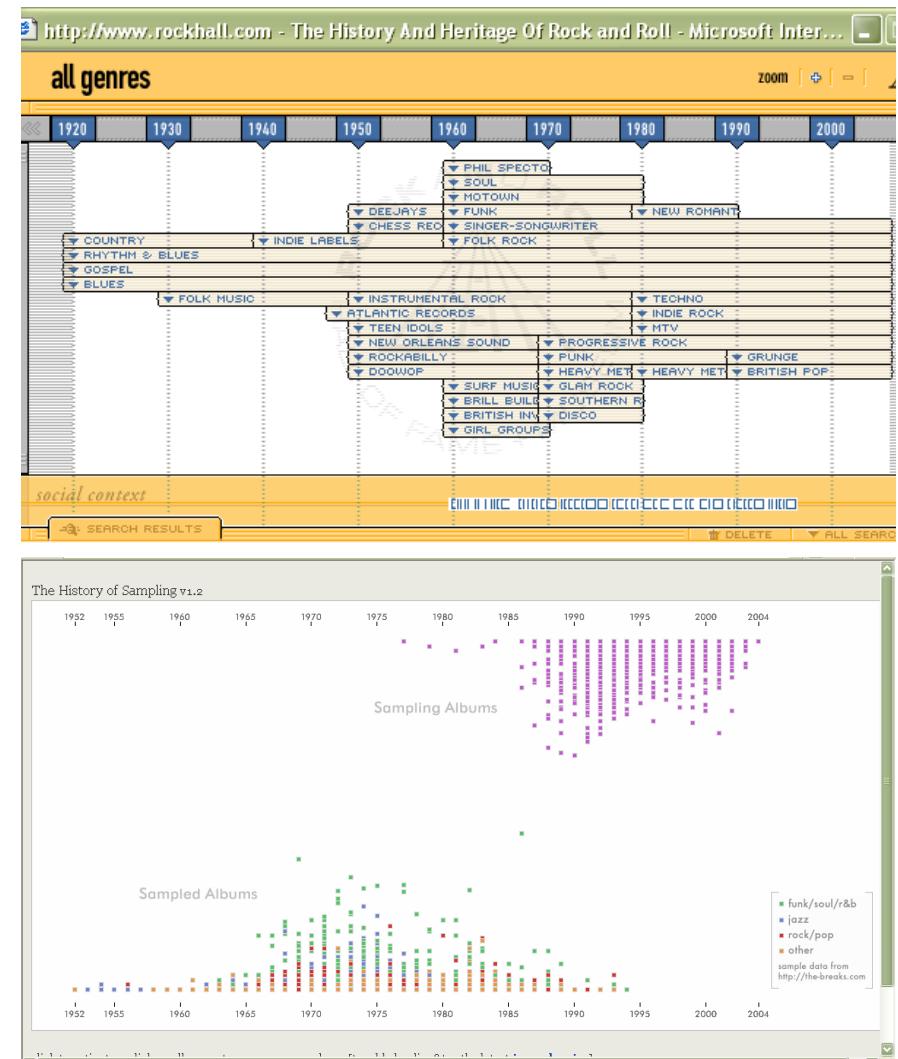
[jessekriess.com/projects/samplinghistory/](http://jessekriess.com/projects/samplinghistory/)



# Music Over Time .....



- Thinking about
  - Rock Hall
  - Sampling History
- What do these two have in common?
- Could elements of one be used in the other?

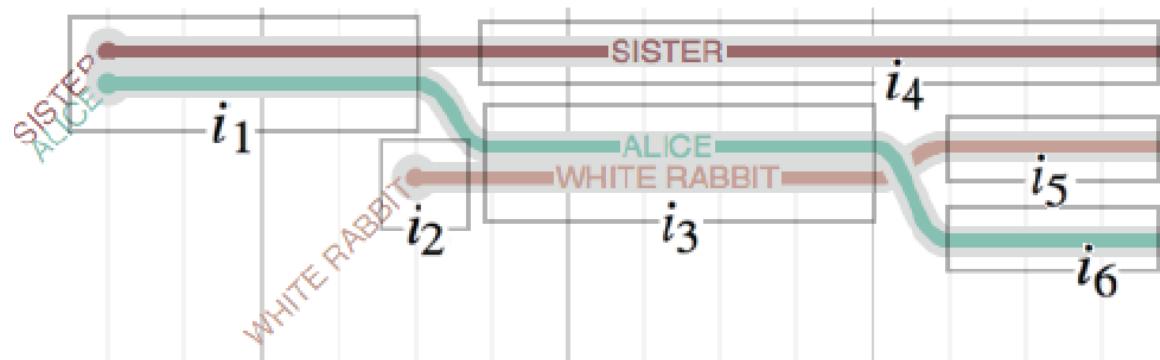


# Storylines

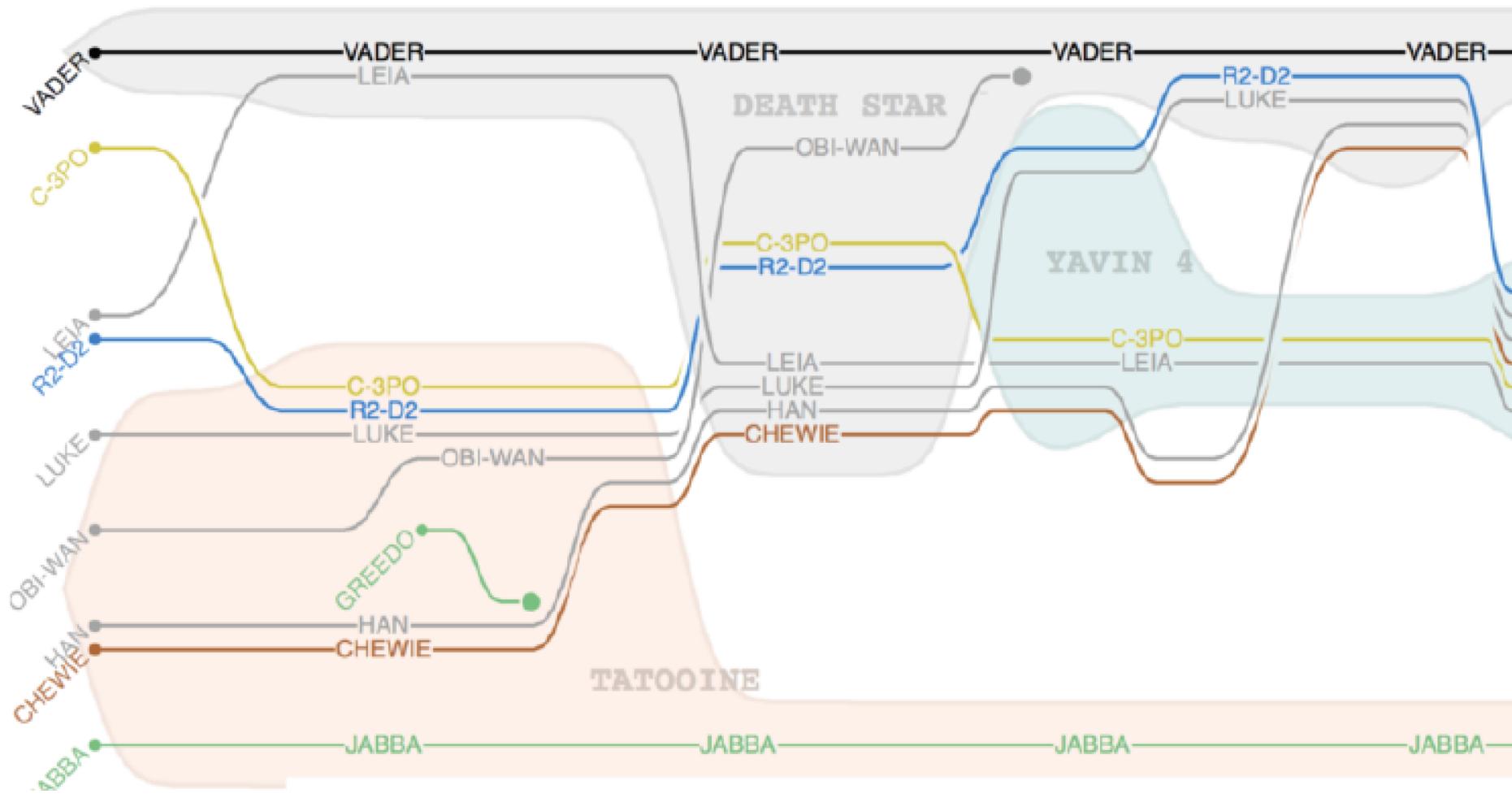


$i_k$	$t_k$	$d_k$	$M_k$
$i_1$	0	4	SISTER, ALICE
$i_2$	4	0	WHITE RABBIT
$i_3$	5	5	ALICE,WHITE RABBIT
$i_4$	5	217	SISTER
$i_5$	11	21	WHITE RABBIT
$i_6$	11	6	ALICE

Sister & Alice  
together from  $t = 0$  for 4 time units



- Design Considerations for Optimizing Storyline Visualizations, Yuzuru Tanahashi and Kwan-Liu Ma, IEEE Transactions on Visualization and Computer Graphics, Dec. 2012



- Lines representing interacting characters must be adjacent.
- Otherwise, lines must not be adjacent.
- A line must not bend except to converge or diverge with another line.

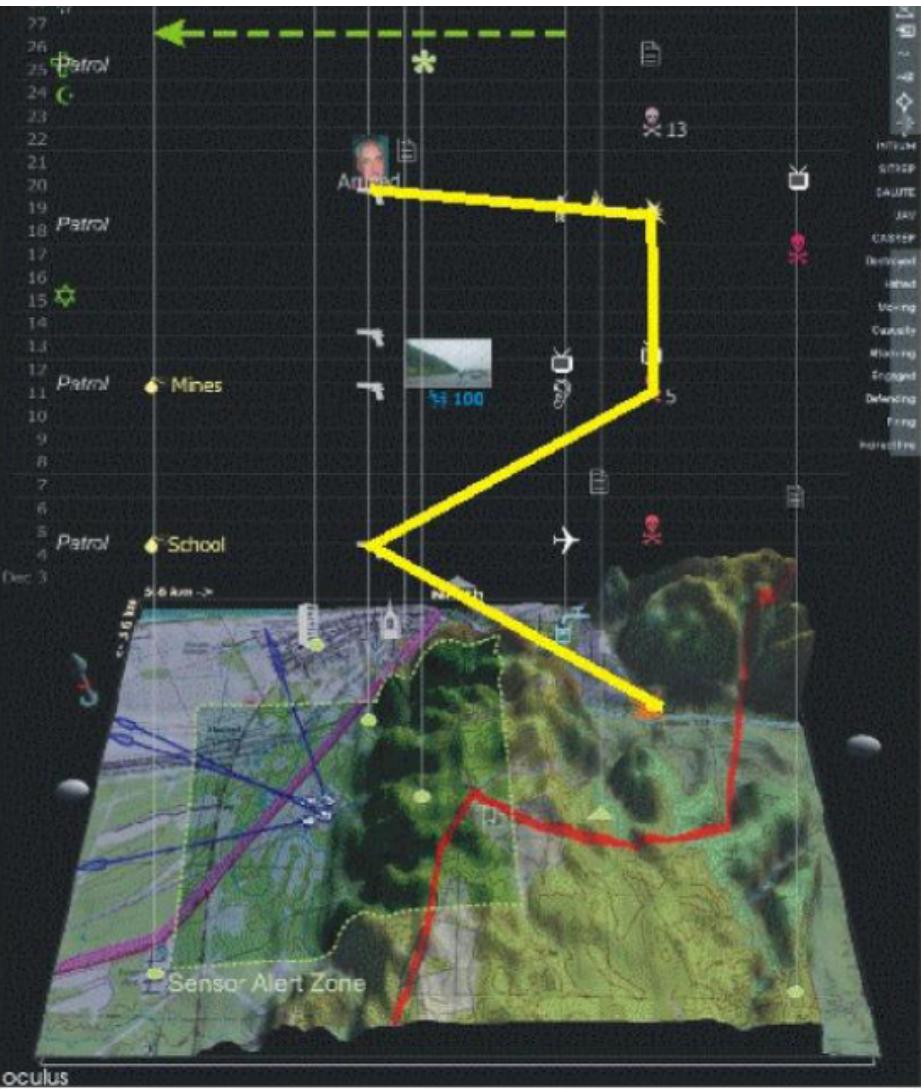
# Example: Time + Geography

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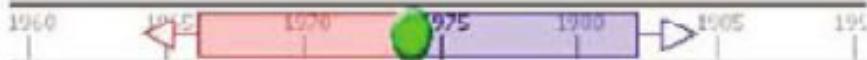
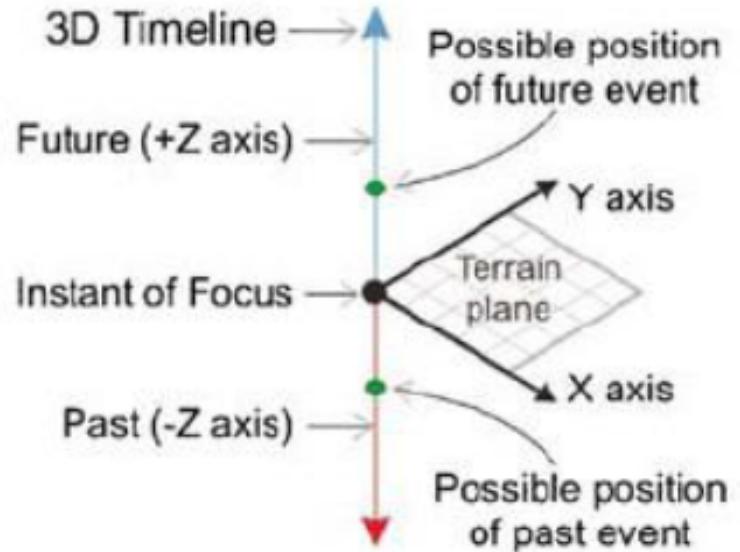


- Typically superimpose temporal events on a map
  - Intelligence analysis
  - Literary plot analysis
  - Military planning
  - Maybe in future plan plots for interactive games
- Following figures from GeoTime, a product of Oculus [www.oculusinfo.com/](http://www.oculusinfo.com/)

# GeoTime Spatial Timelines



- Vertical time axis (z-axis)
- Terrain plane (xy)



# GeoTime Example

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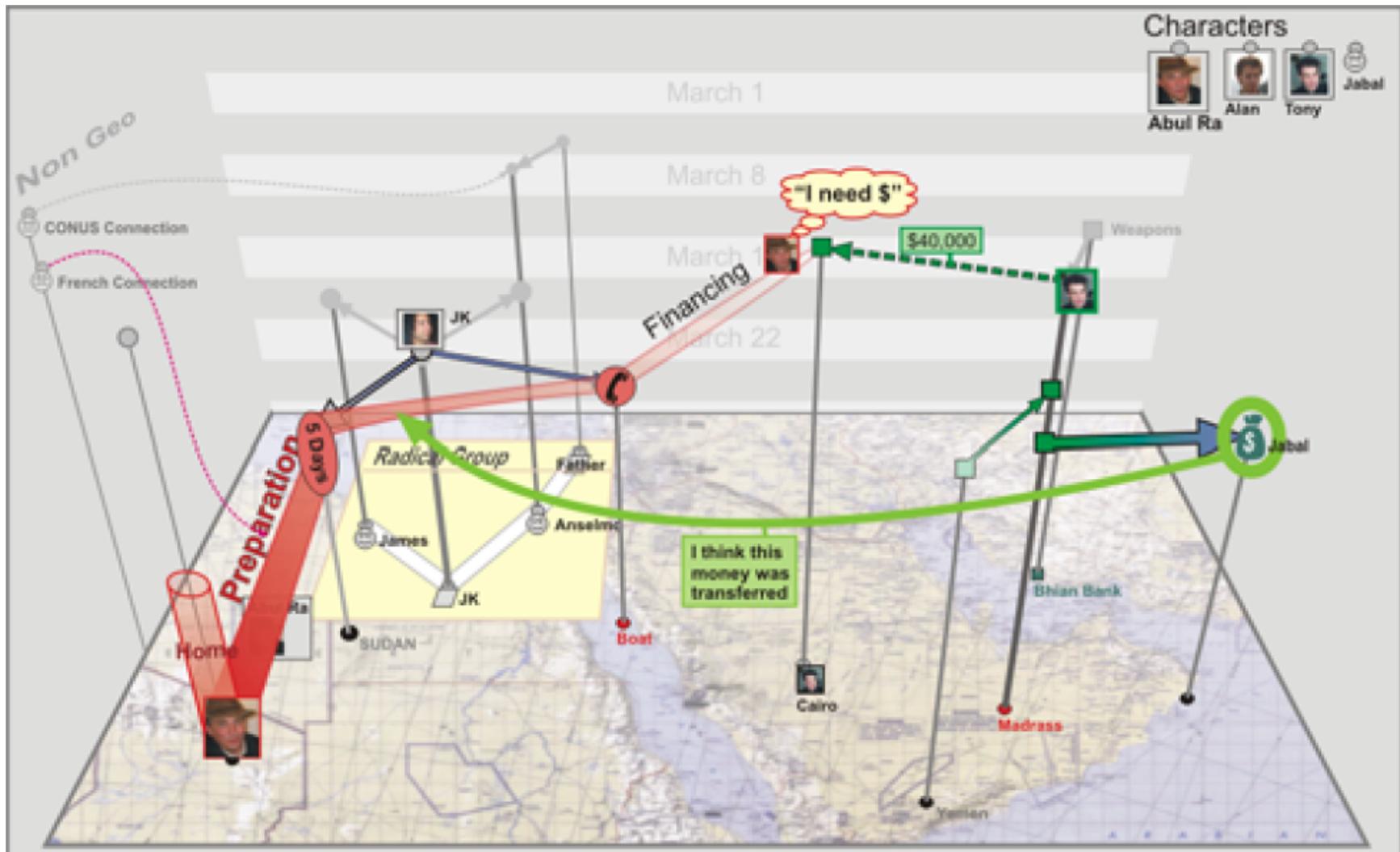
- From <http://www.youtube.com/watch?v=YUCgeXXeEiU&feature=related>
- My file
  - GeoTime\_ Investigating IED Attacks.flv

# Time and Geography Story



Or an intelligence analysis ...

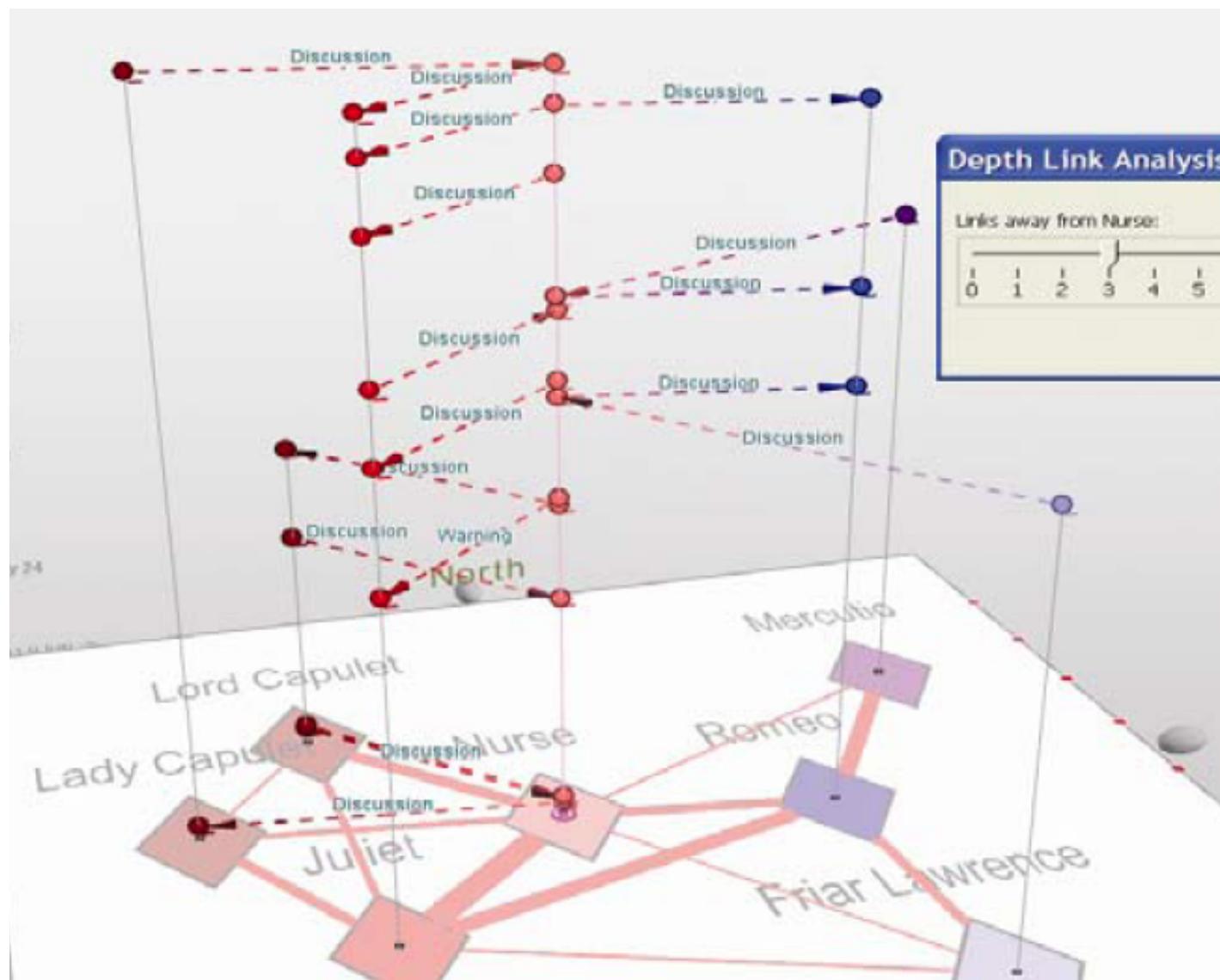
GeoTime



# Literary Dialogue



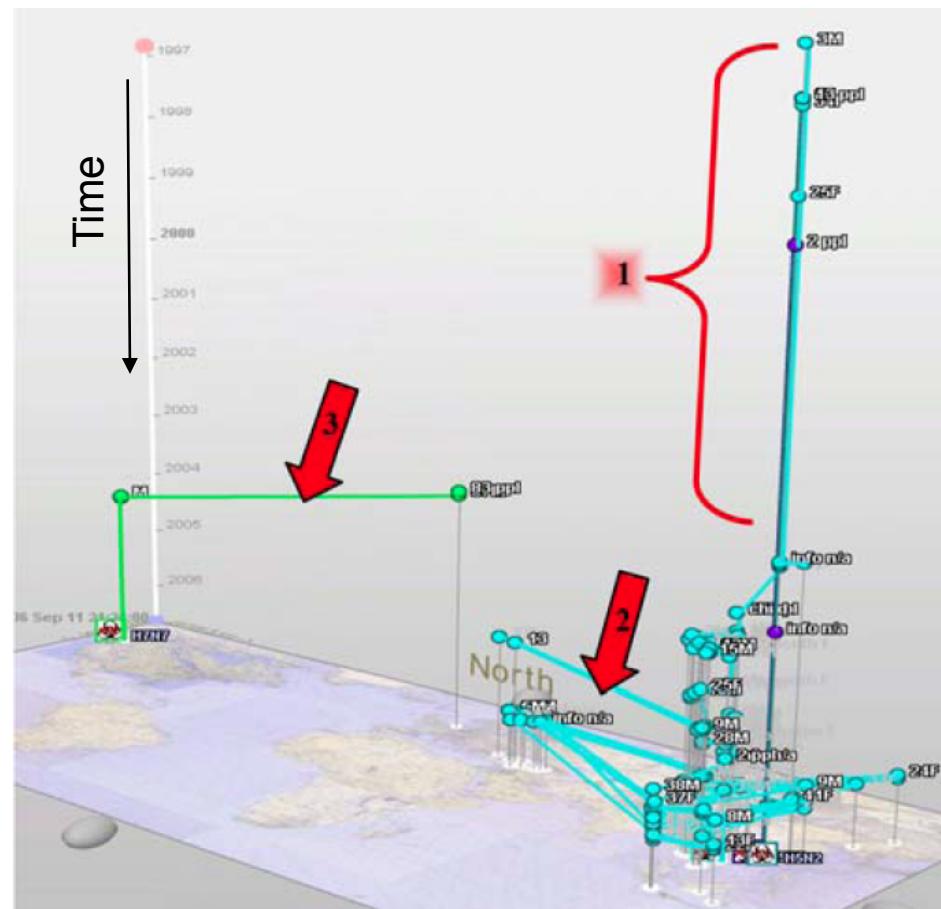
Discussion  
between Romeo  
and Juliet, filtered  
to just show  
those connected  
to the nurse.



# Avian Flu Spread

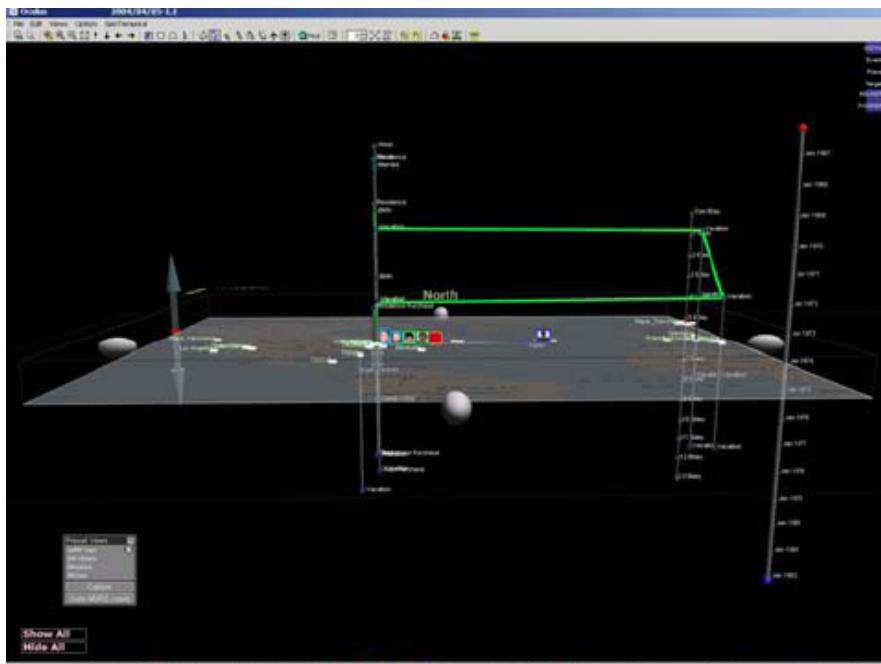


- Worldwide human cases of avian flu. Sporadic localized activity seen in Asia until 2003 (1).
- H5N1 cases increased in frequency in 2004 (2) with the bulk of disease activity in Asia.
- Isolated incidents of strain H7N7 found in Canada and Europe (3).

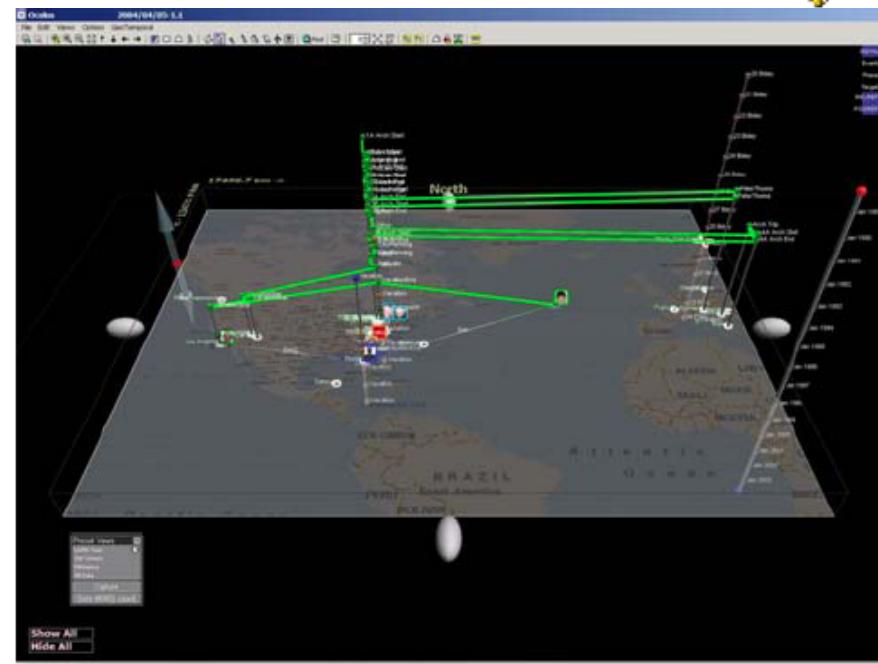


Proulx et al, *Avian Flu Case Study with nSpace and GeoTime*, IEEE CS4460 VAST '08

# Interaction in GeoTime



Time slider at bottom  
Moveable time scale at right  
Green line traces one entity's  
movement in time and geography



Overhead view  
Time slider advanced from view on left

*Plus lots more interaction – what would you want?*

# Time Series Tasks – More??

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- Compare two time series
- Find highs and lows
- Determine periodicity
- When did X happen?
- Did A happen before or after B?
  - Or did they occur simultaneously?
- How long did it take?
- When will it happen again?
- How often did X occur?
  
- What else did we see happening?

# Wrapping up Time – Some Take-aways

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- How decide what type of Infovis to use with what type of temporal data?
  - Temporal data types – remember continuous, discrete, periodic
  - Which of the examples work with which types?
- Compressing/expanding time axis
- Dependencies (as in PERT charts)
- It is not just time, it is time plus other data
  - Possibly including maps
- When to use Infovis, when not to?

# The End



# Older Material Follows

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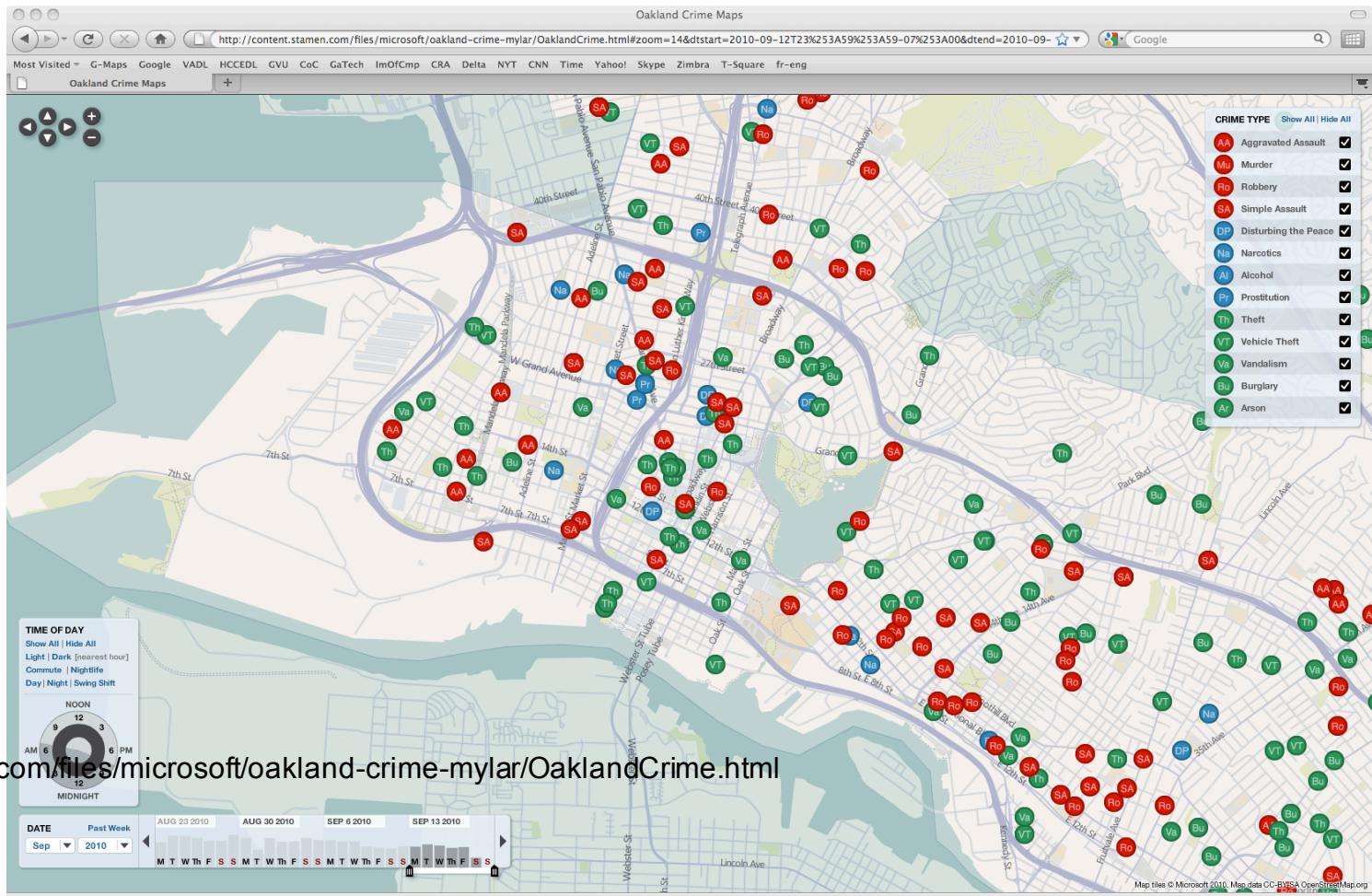


- No longer used but relevant for digging further.

# Interactions in Space and Time



## What interaction methods are used here?



# Example: Computer Logs

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- (Huge) data sets
- How can you examine millions of lines to debug or locate a problem?
- Goal: Want to look for unusual circumstances, patterns, etc.

# MieLog Computer Log Inspector

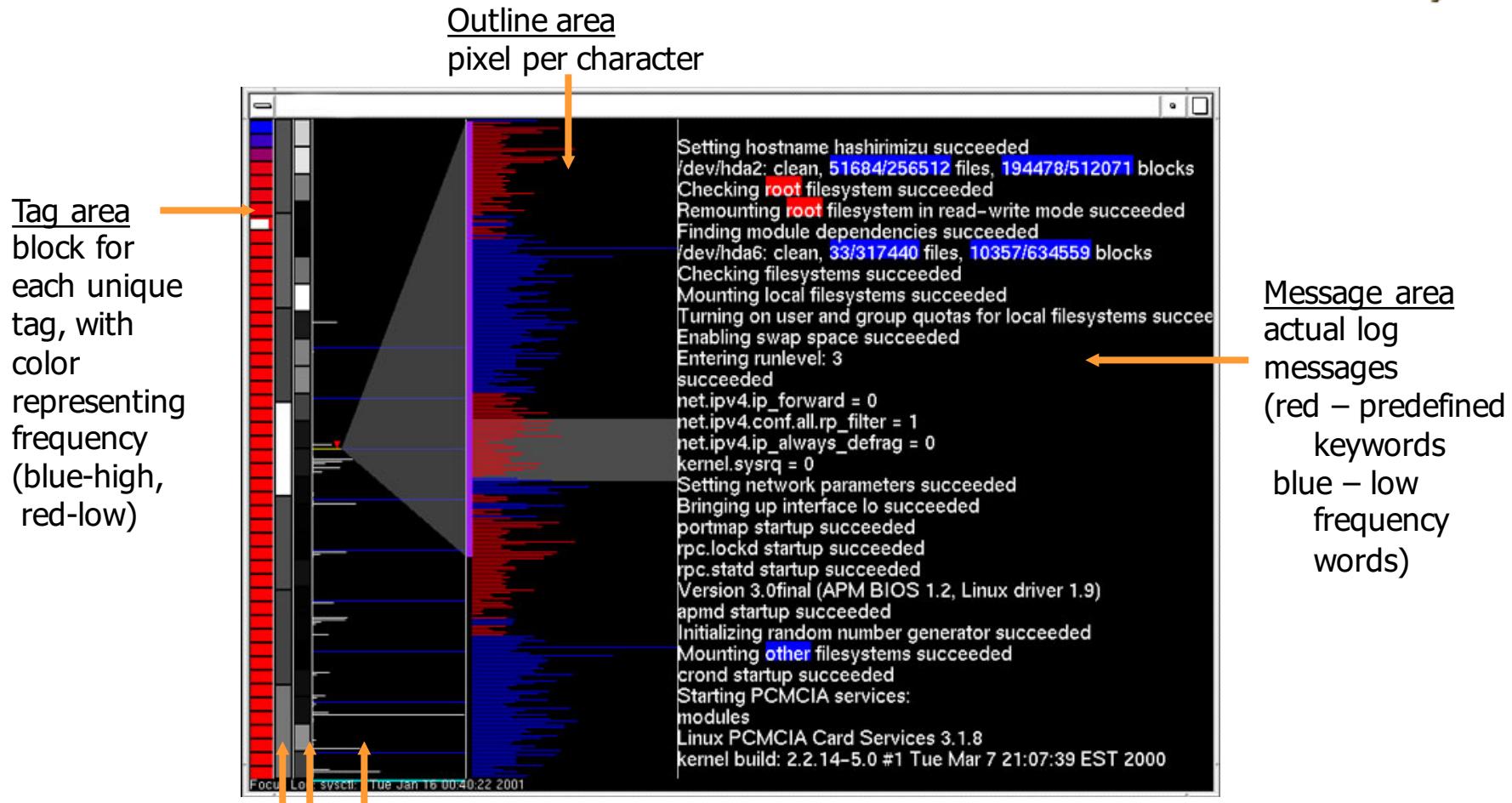
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- Goal: Help computer system administrators examine log files.
- How would you do this?

Takada & Koike, *MieLog: A Highly Interactive Visual Log Browser Using Information Visualization and Statistical Analysis*, LISA 16<sup>th</sup> Sys Admin Conference, USENIX, 2002

# MieLog View



Time area  
days, hours, &  
frequency histogram  
(grayscale, white-high)

Note inconsistent use of color coding

# MieLog Close-up View



Change in  
color coding?

```
./mieilog
sgi-esphttp/tcp: unknown service
/var/spool/lw_lpd/errlog: No such file or directory

Software installation has installed new configuration fi
the previous version in some cases. You may need t
old configuration files with the newer versions. See t
Configuration Files" section in the versions(1M) manua
The shell command "versions changed" will list the af

These directories were unable to be moved properly
installation process. Check for any user-modified files
delete the directories.
/usr/include/Vk.O
{start,stop}midi entered
zetaka: login
WARNING: ARP: got MAC address on ec for BCAS-
failed: ttyq2 changing from zetaka to root
succeeded: ttyq2 changing from zetaka to root
succeeded: ttyq2 changing from zetaka to root
succeeded: ttyq2 changing from zetaka to root
connection from 130.153.133.2
FTP LOGIN FROM 130.153.133.2 as zetaka
zetaka@bologna.vogue.is.uec.ac.jp as zetaka
WARNING: ARP: got MAC address on ec for BCAS-
cynthia@torino.vogue.is.uec.ac.jp as cynthia
1 - [ 4588 ] - 4901 ( 4901 ) syslog
```

# MieLog Interactions

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- Tag area
  - Click on tag shows only those messages
- Time area
  - Click on tiles to show those times
  - Put line on histogram to filter on values above/below
- Outline area
  - Can filter based on message length
  - Just highlight messages to show them in text
- Message area
  - Can filter on specific words

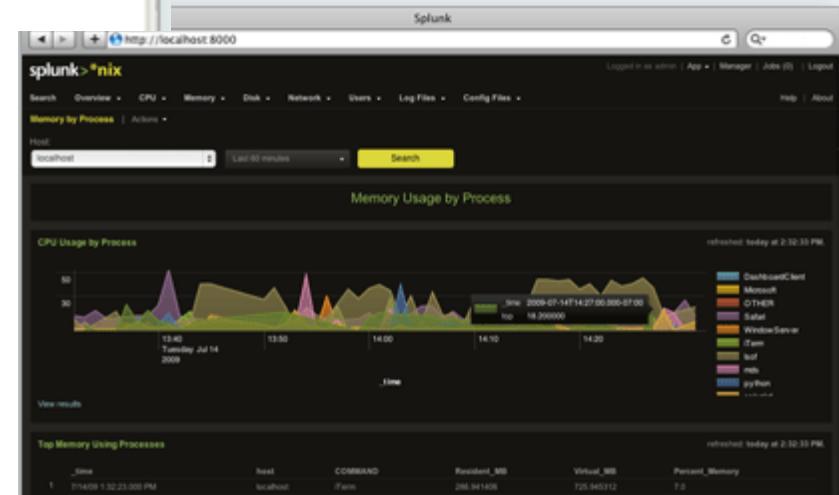
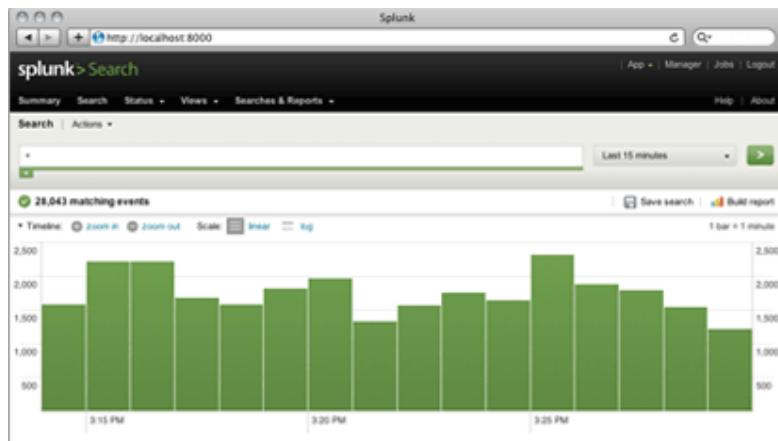
# MieLog Pros/Cons

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- Strengths and Weaknesses?
- Usable in other domains?

# Commercial Log Inspector!



# End



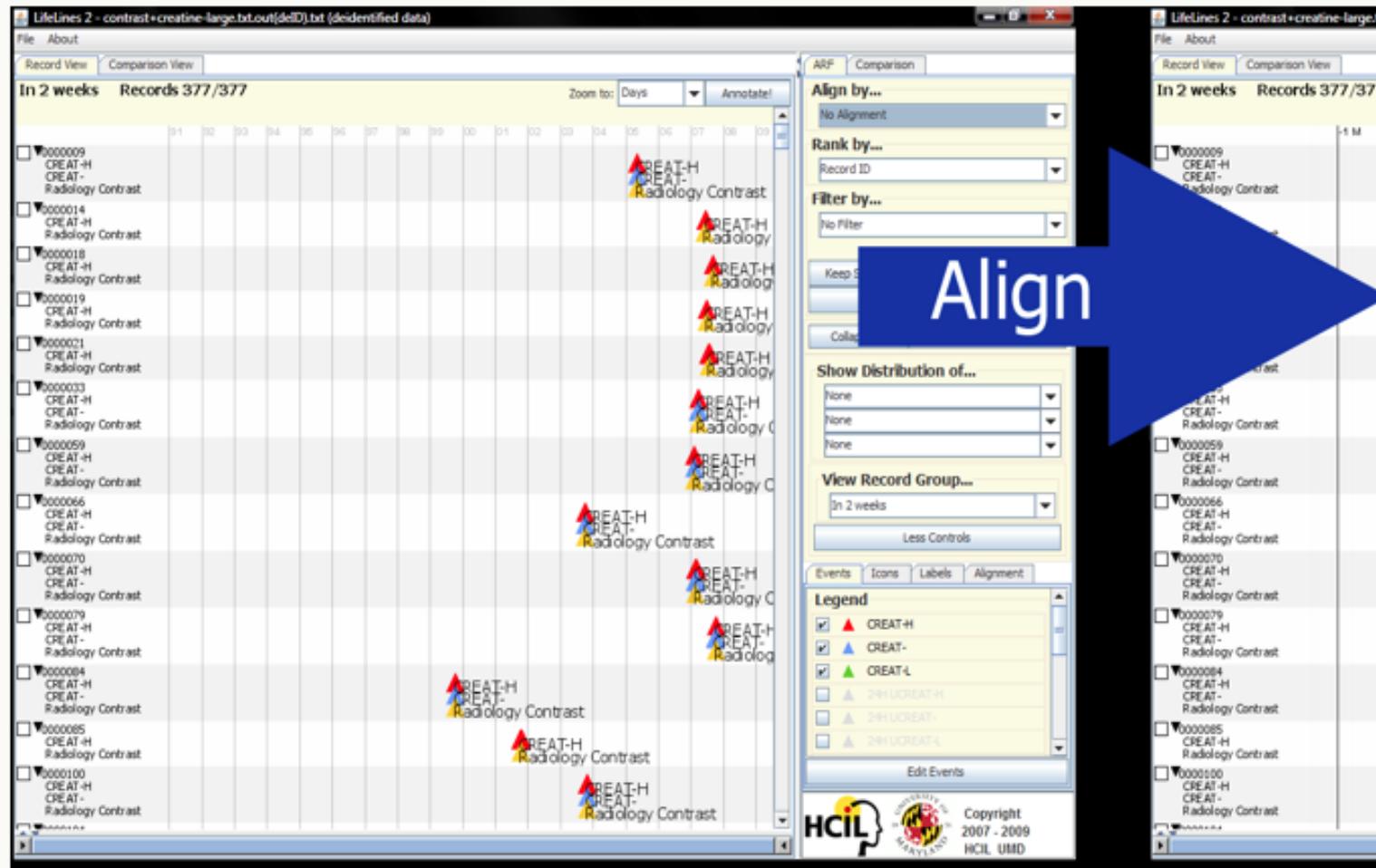
# Example: Find Patterns in TimeLines

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- Want to find patients who received contrast agent for medical imaging and within two weeks had high levels of creatinine (indicating renal problems).
- <http://www.cs.umd.edu/hcil/lifelines2/>

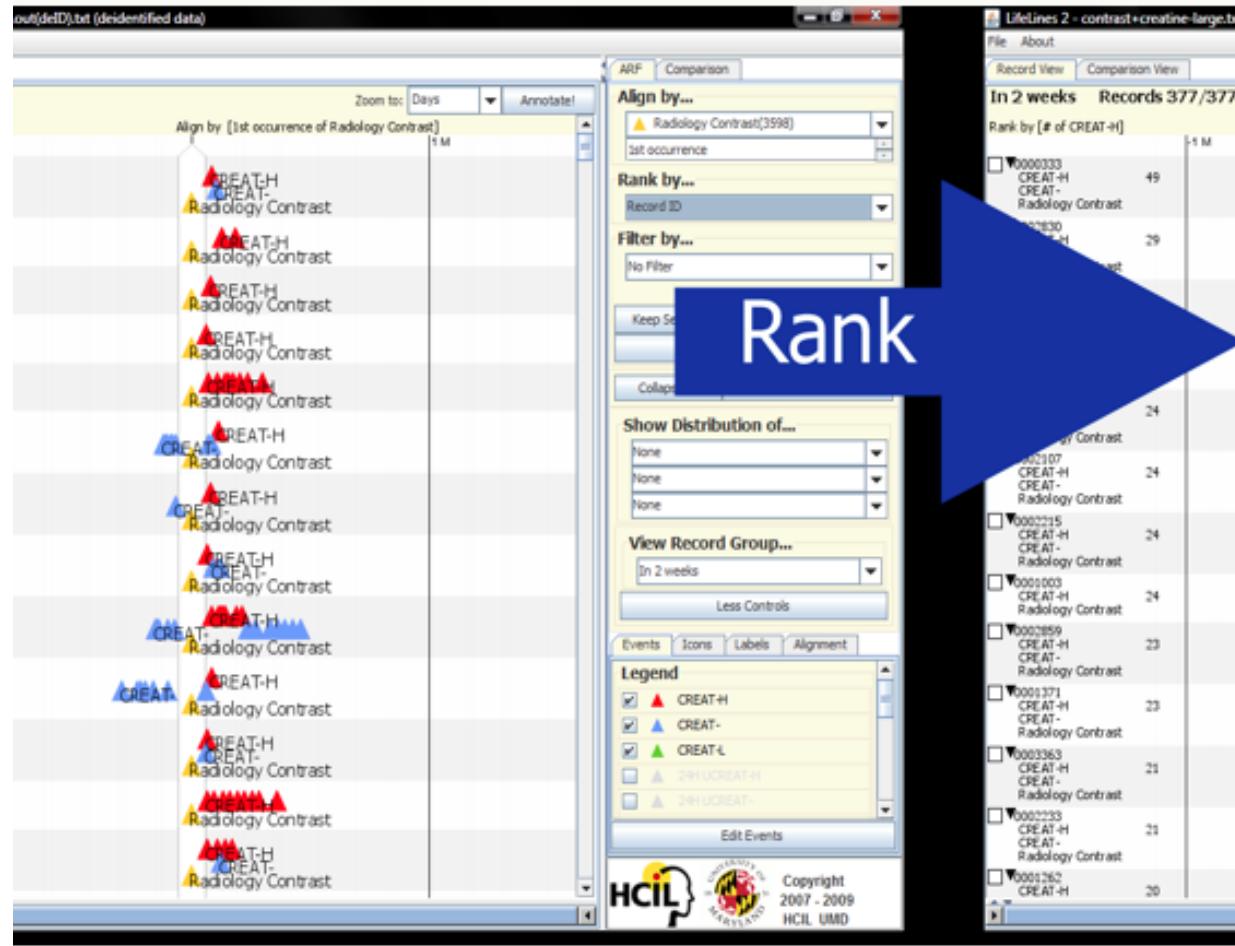
# Step 1: Unaligned Med. Records



# Step 2: Align Event Times



Yellow triangles  
(when contrast agent administered) all aligned

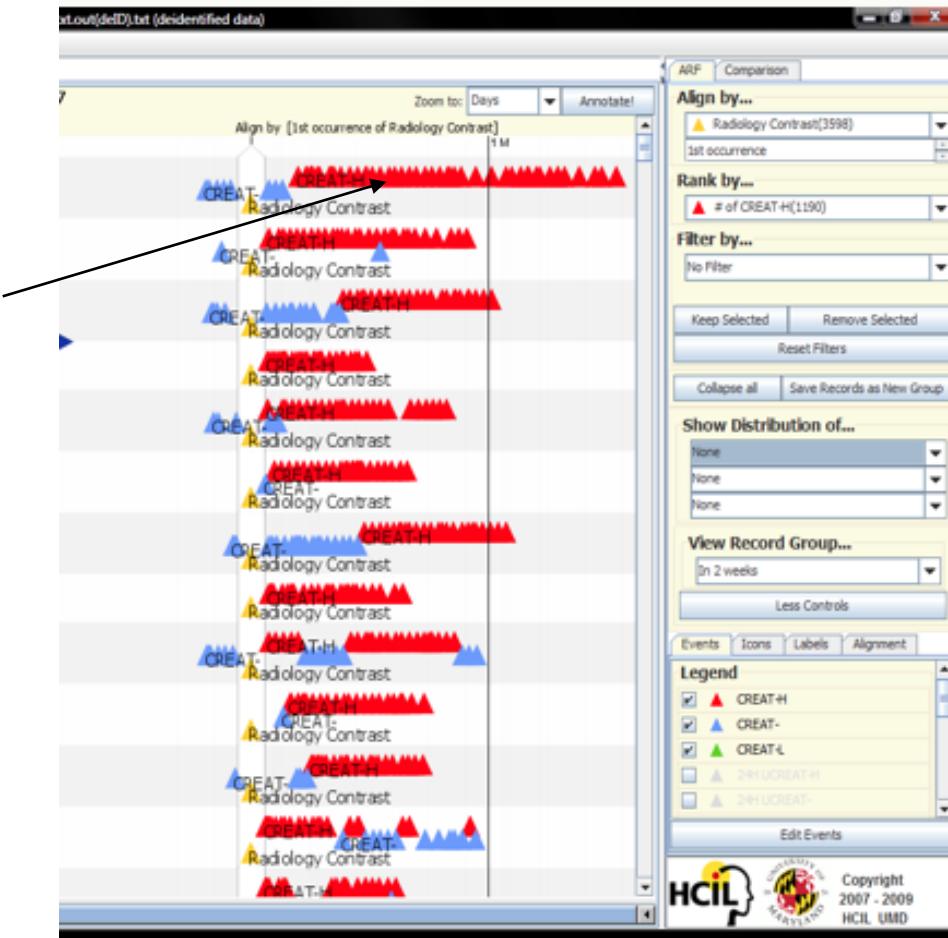


# Step 3: Rank by Creatinine Level

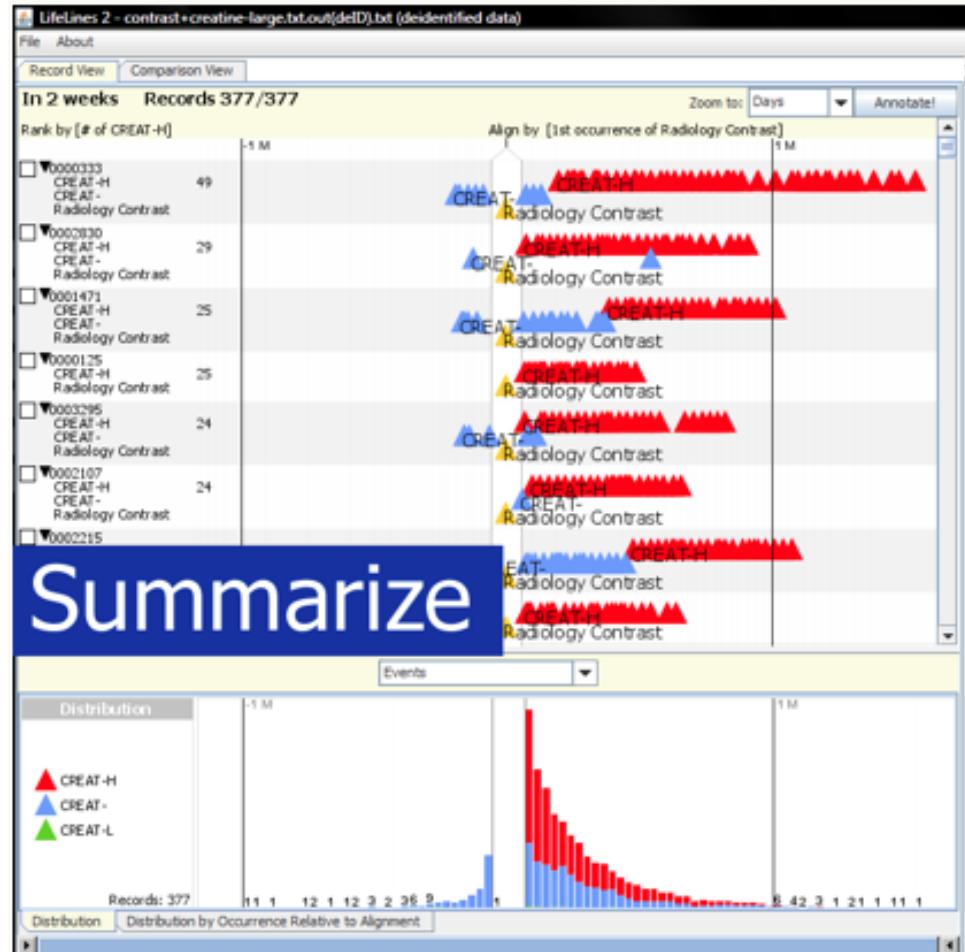


Sort by  
Creatinine  
Level

Highest at  
top (red  
triangles)



# Step 4: Summarize Across Cases

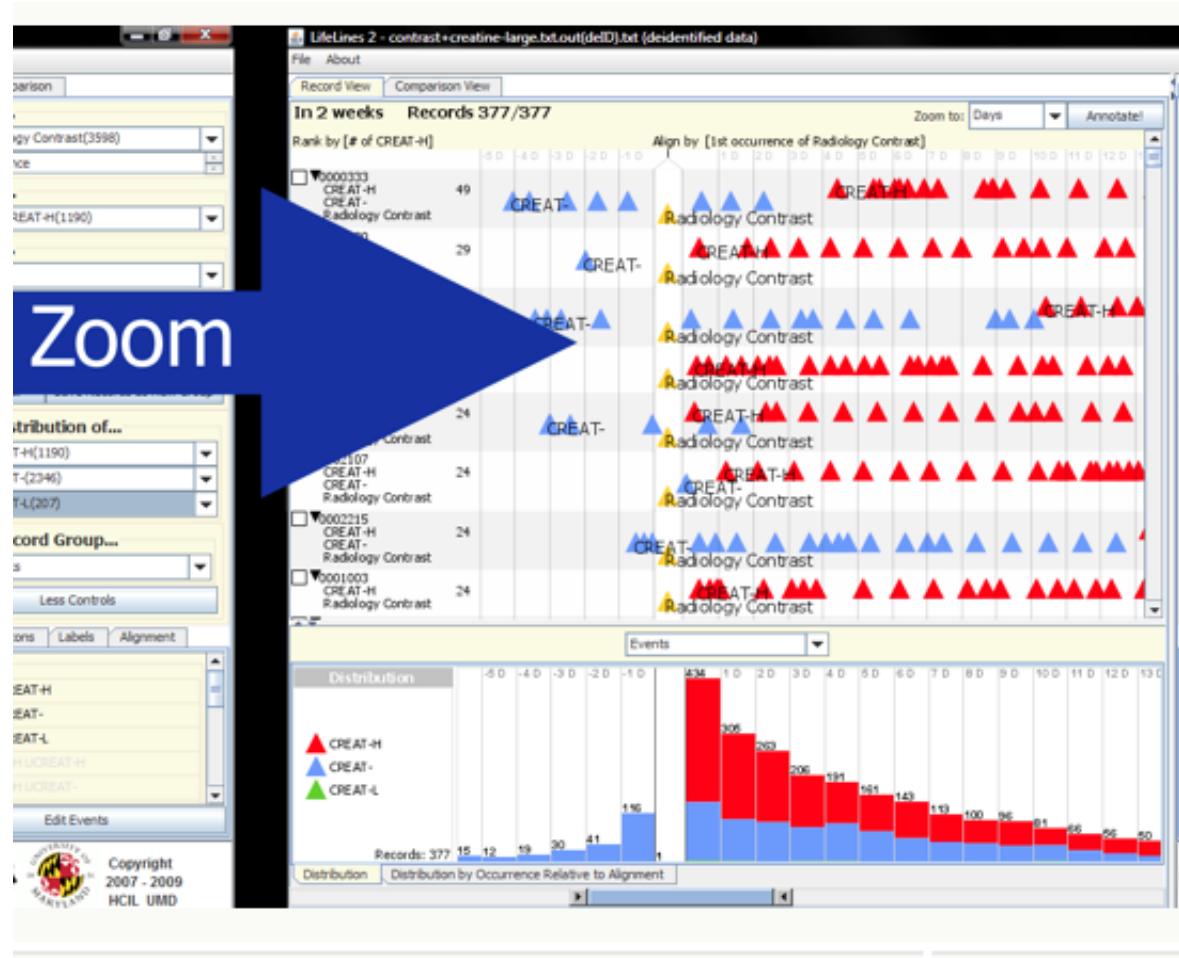


Histogram  
across cases

# Step 5: Expand Time Line



Expand  
time line to  
see more  
detail



Video: [http://www.cs.umd.edu/hcil/lifelines2/videos/Lifelines2-%28Contrast-Creatinine%29-11-10-08\\_flash/full%281024x768%29/index.htm](http://www.cs.umd.edu/hcil/lifelines2/videos/Lifelines2-%28Contrast-Creatinine%29-11-10-08_flash/full%281024x768%29/index.htm)

# Finding Unknown Periodicity

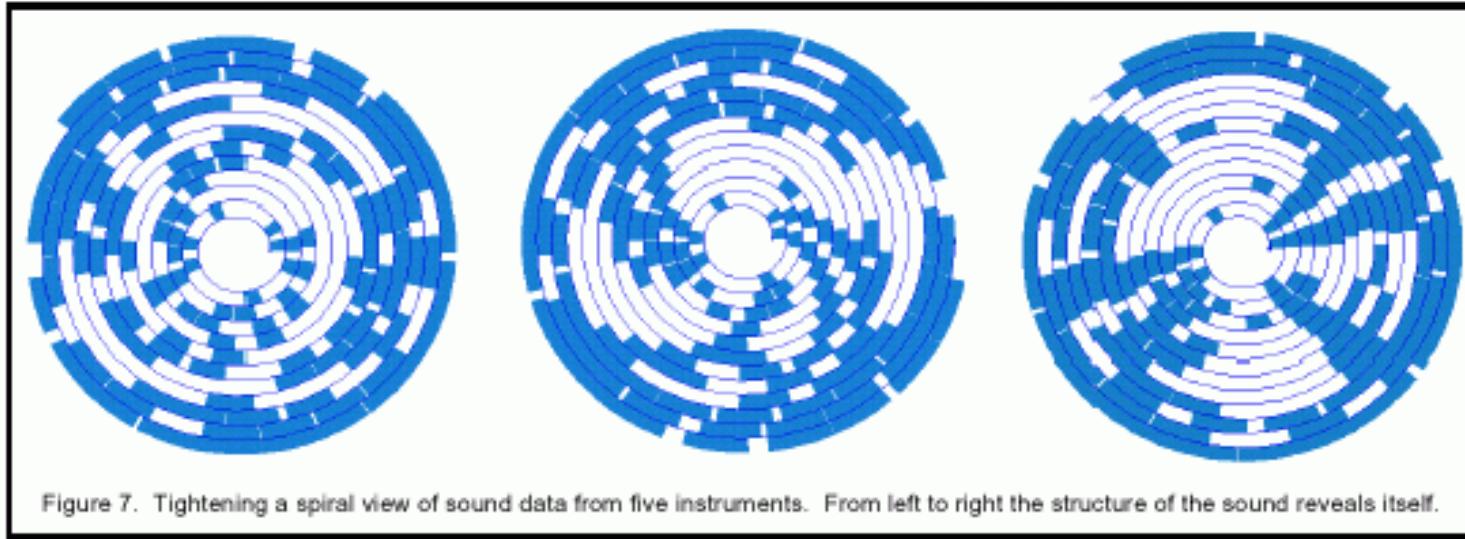


Figure 7. Tightening a spiral view of sound data from five instruments. From left to right the structure of the sound reveals itself.

- Find unknown periodicity by interactively tightening/loosening the spiral
  - Mathematical tools can also find periodicity ☺
- What if is no periodicity?

# Example: Text Themes over Time

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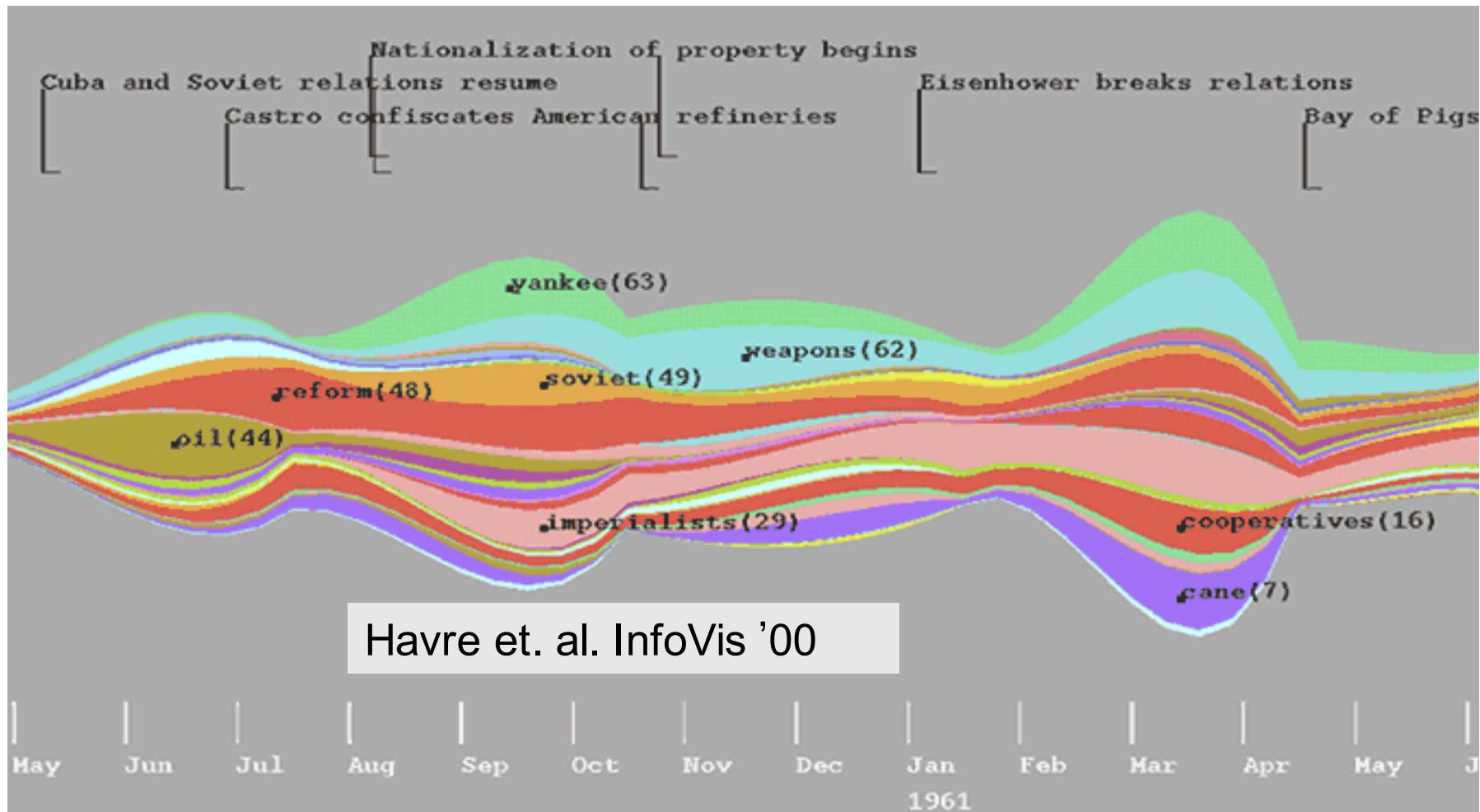


- Consider a set of speeches or documents over time
  - How represent the flow of ideas and concepts over time?  
Was an InfoVis student contest
- How would you do this?
- Any related concepts?

# Theme River



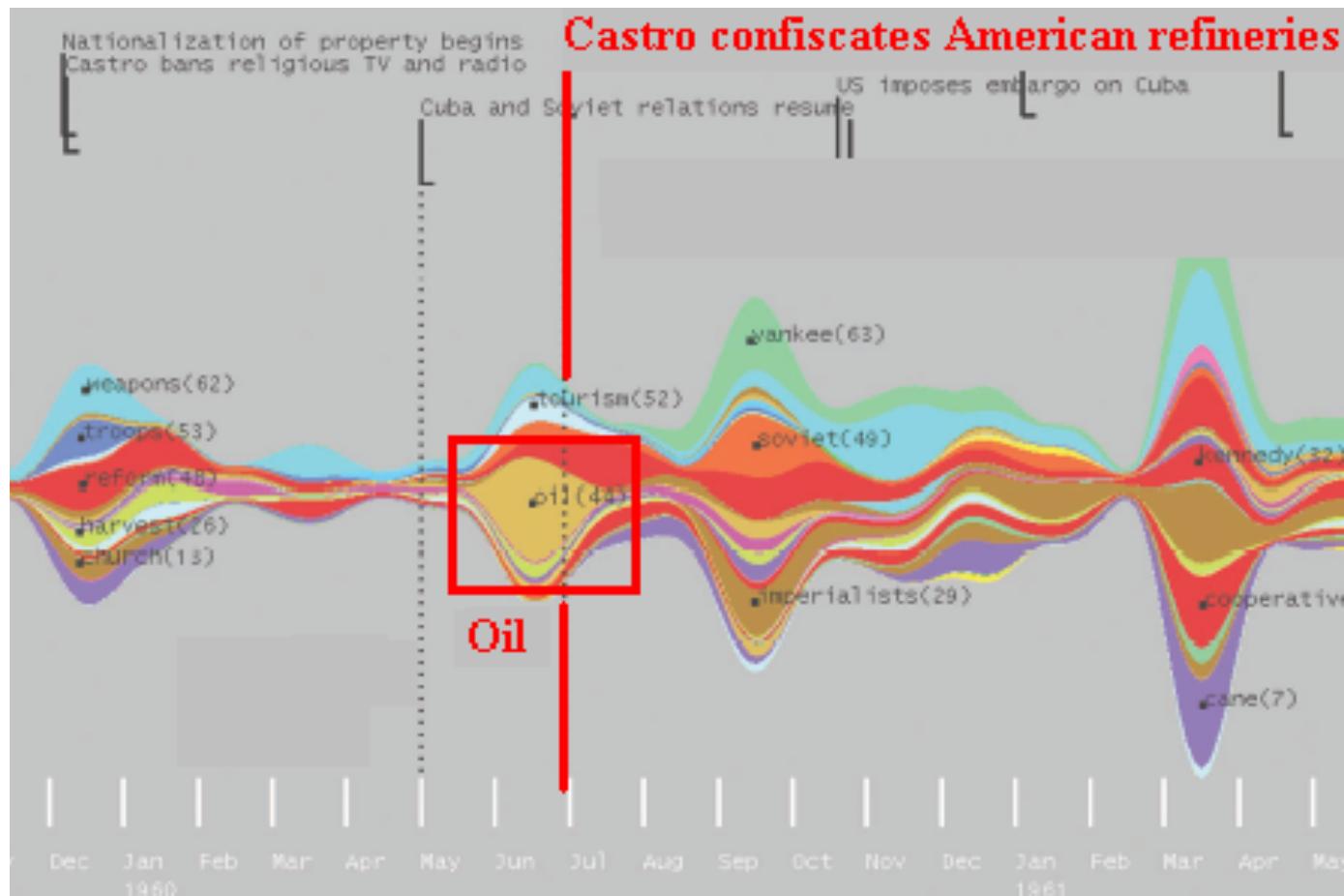
- Each ‘theme’ from news stories is a ‘river’



# Theme River



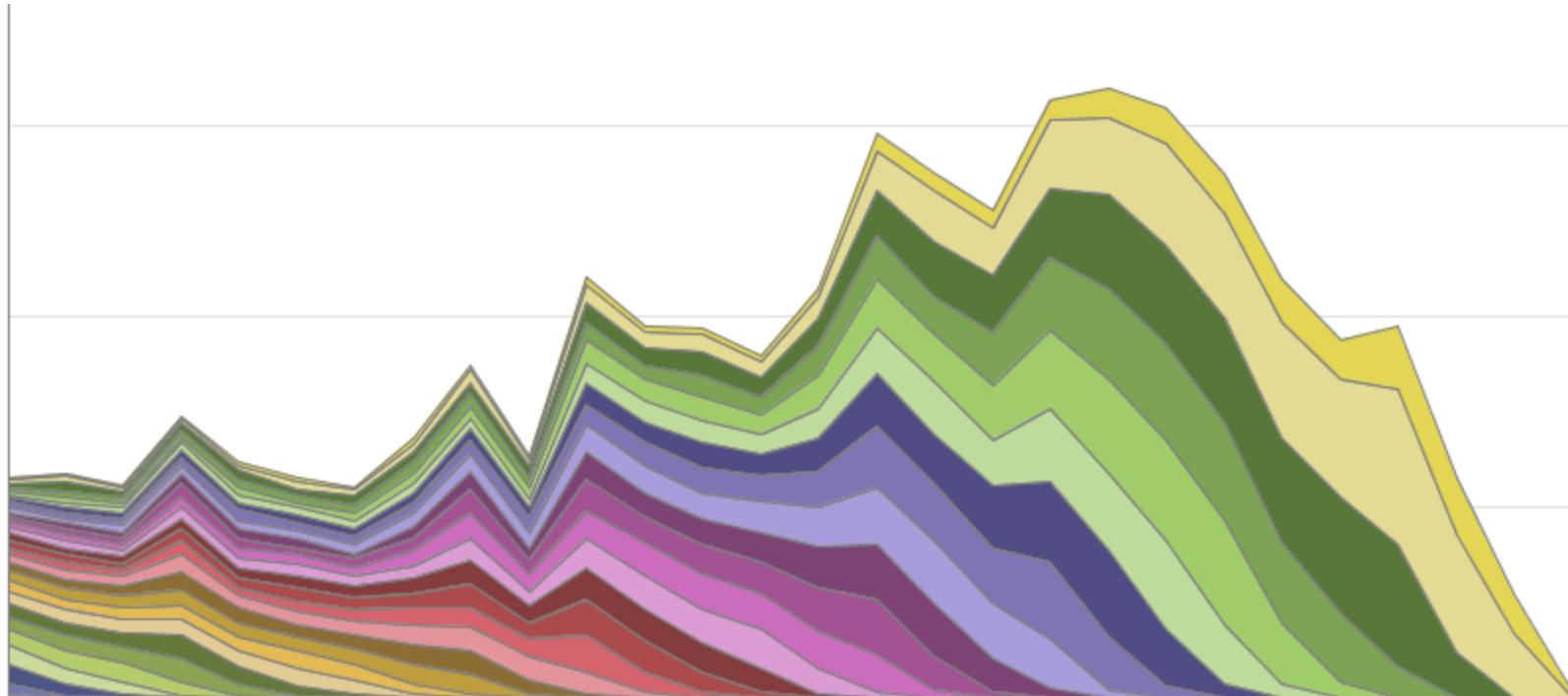
- River height (thickness) encodes relative frequency of themes
- Key events overlaid



# Theme River = Stacked Graph?



- Yes, with a differential vertical offset
  - Makes a world of difference!



# Example: Querying

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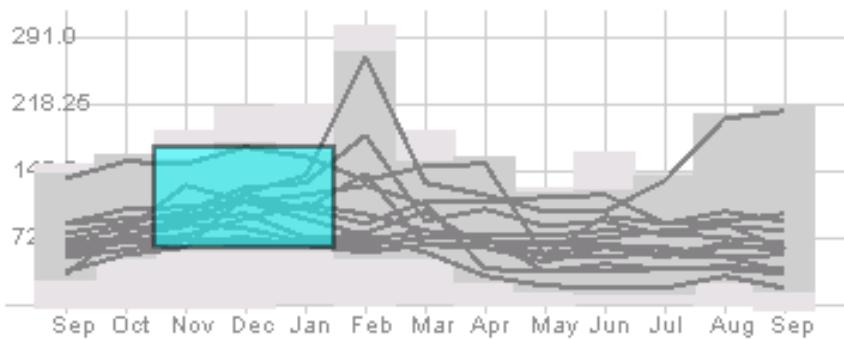
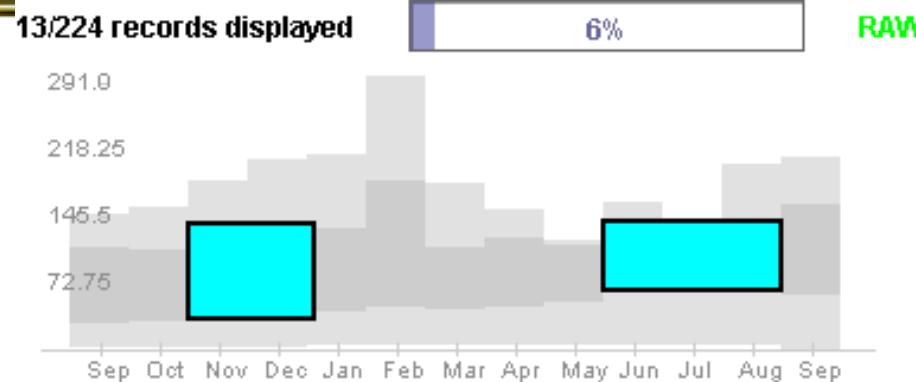
- Most systems focus on visualizing and navigating time-series data.
- What about *querying*?

# TimeFinder



RAW

Can create rectangles  
that function as matching  
regions



Multiple boxes are “anded”

Light gray is all data's extent

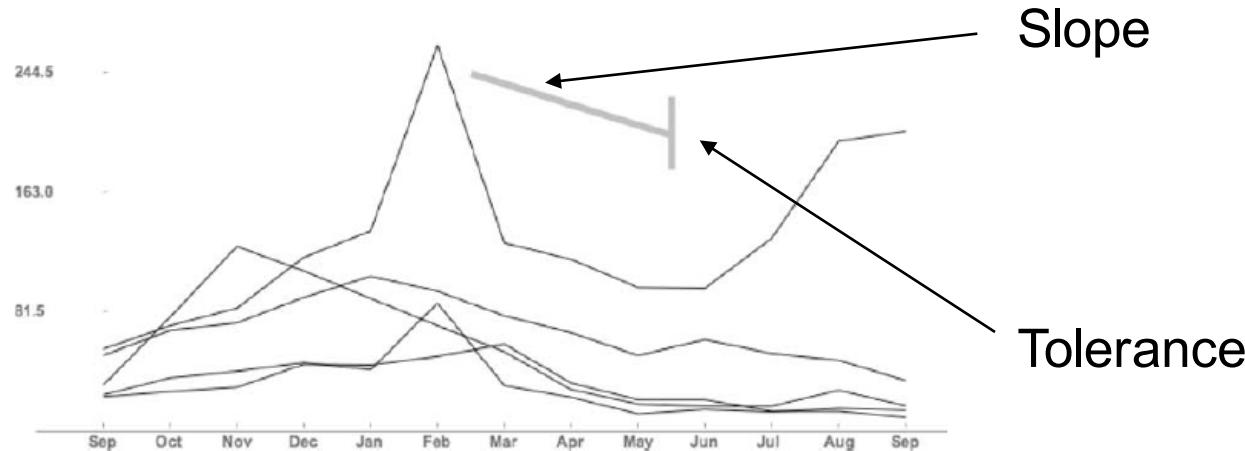
Darker grayed region is data envelope that shows extreme values of queries matching criteria

Hochheiser & Shneiderman  
Proc. Discovery Science '01  
Info Vis '04

# TimeFinder – Other Capabilities



- Search for matches based on angle (slope)  
 $\pm$  tolerance



- “Leaders and laggards”
  - Find same patterns but shifted in time

# TimeFinder Limitations

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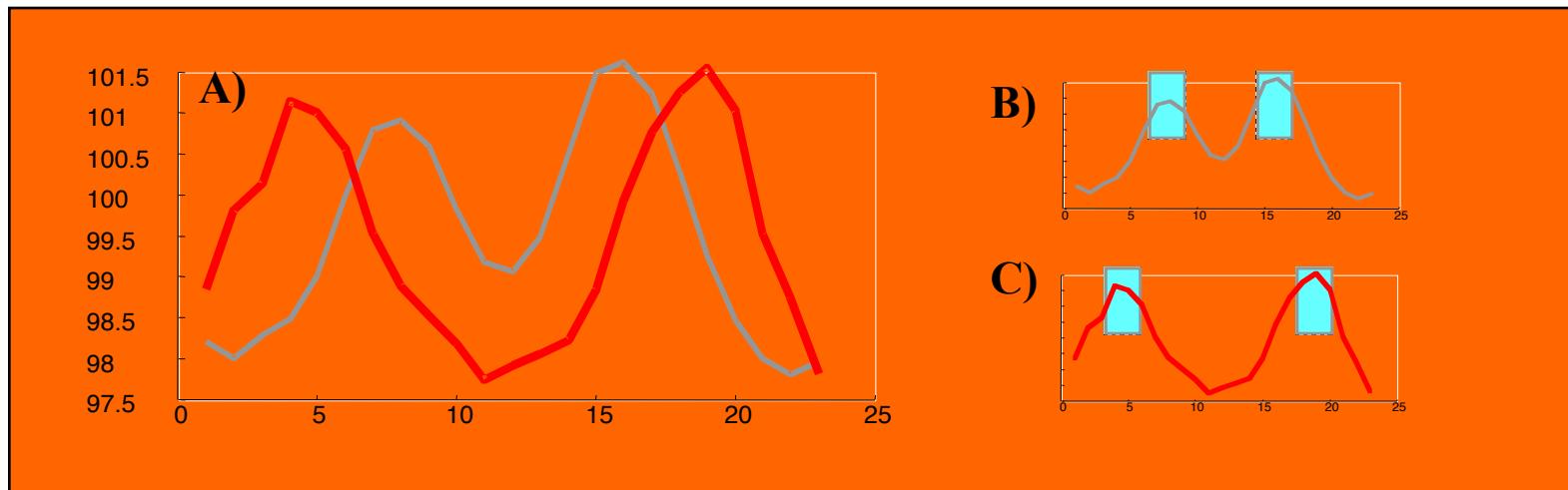


- What are they?
  - (Hint, there's a fundamental problem!)

# TimeFinder Limitations



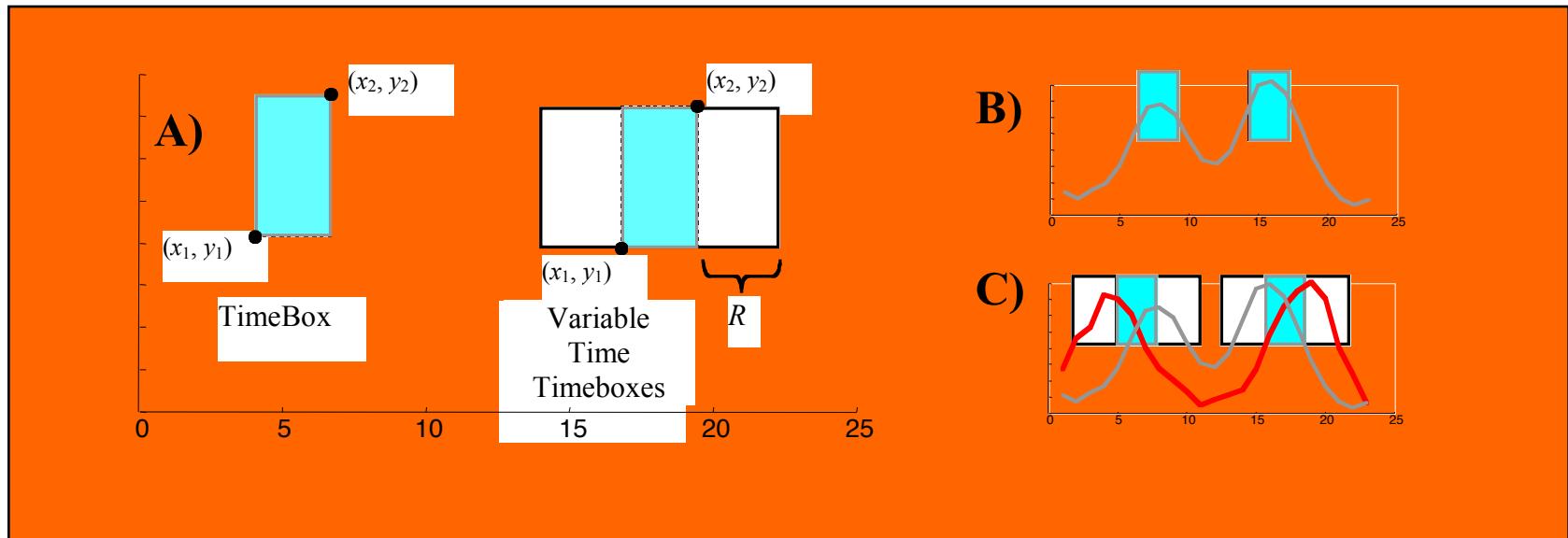
- Hodgkins patients exhibit double spike in temperature...
  - But with differing times between spikes



# Example: TimeSearcher

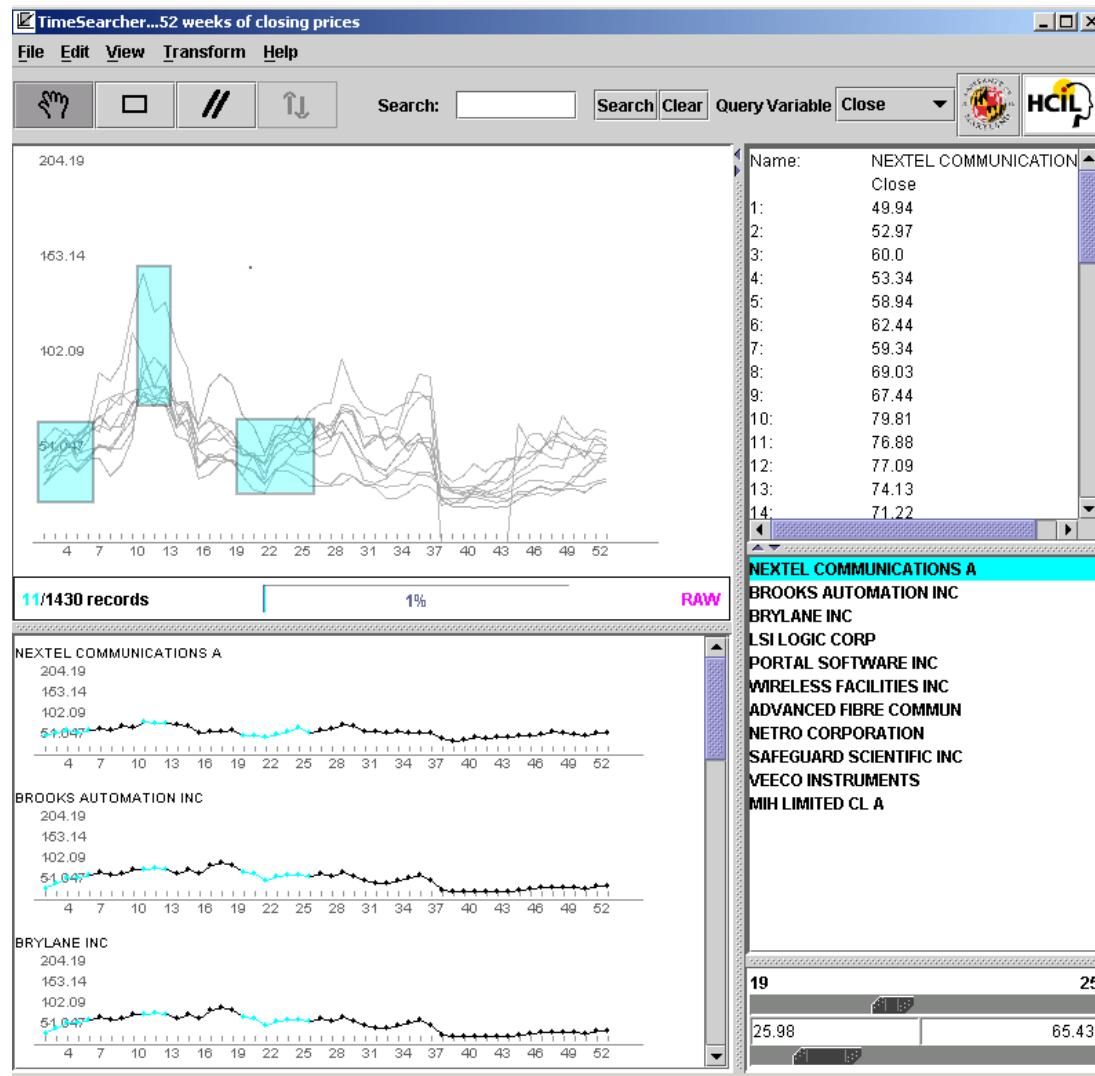


- Overcomes TimeFinder limitation
- Allow time boxes with deltas on each side  
(TimeSearcher) **Video:** 2005\_time searcher.mpg



Buono, Plaisant, Simeone, Aris, Shneiderman, et.al, *Similarity-Based Forecasting with Simultaneous Previews: A RiverPlot Interface for Time Series Forecasting*, 11th International Conference on Information Visualization, 2007

# TimeSearcher

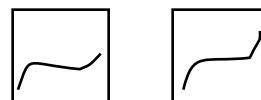
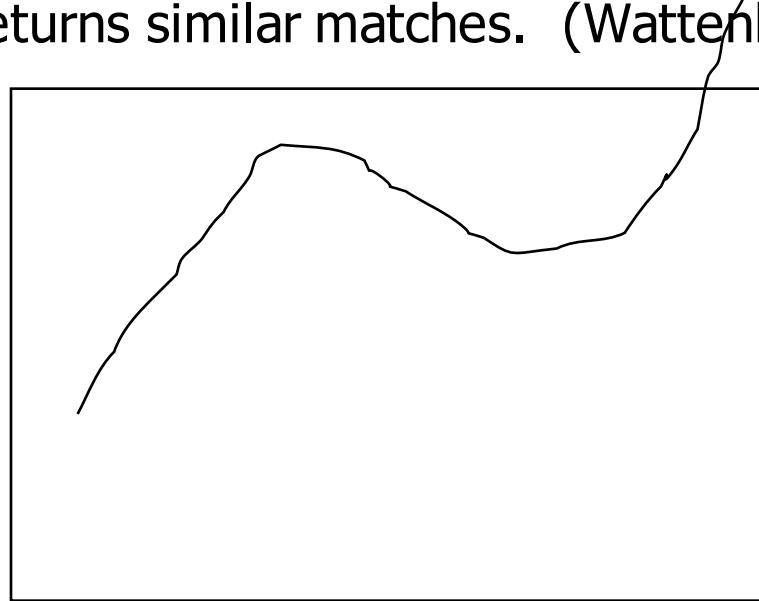


# Example: Query by (Graphical) Example



- Sketch the Query
- Also discussed in Interaction Lecture
  - Specify a timeline query by drawing a rough pattern for it and the system returns similar matches. (Wattenberg, CHI '01)

User-drawn  
query



# Example: Project Management

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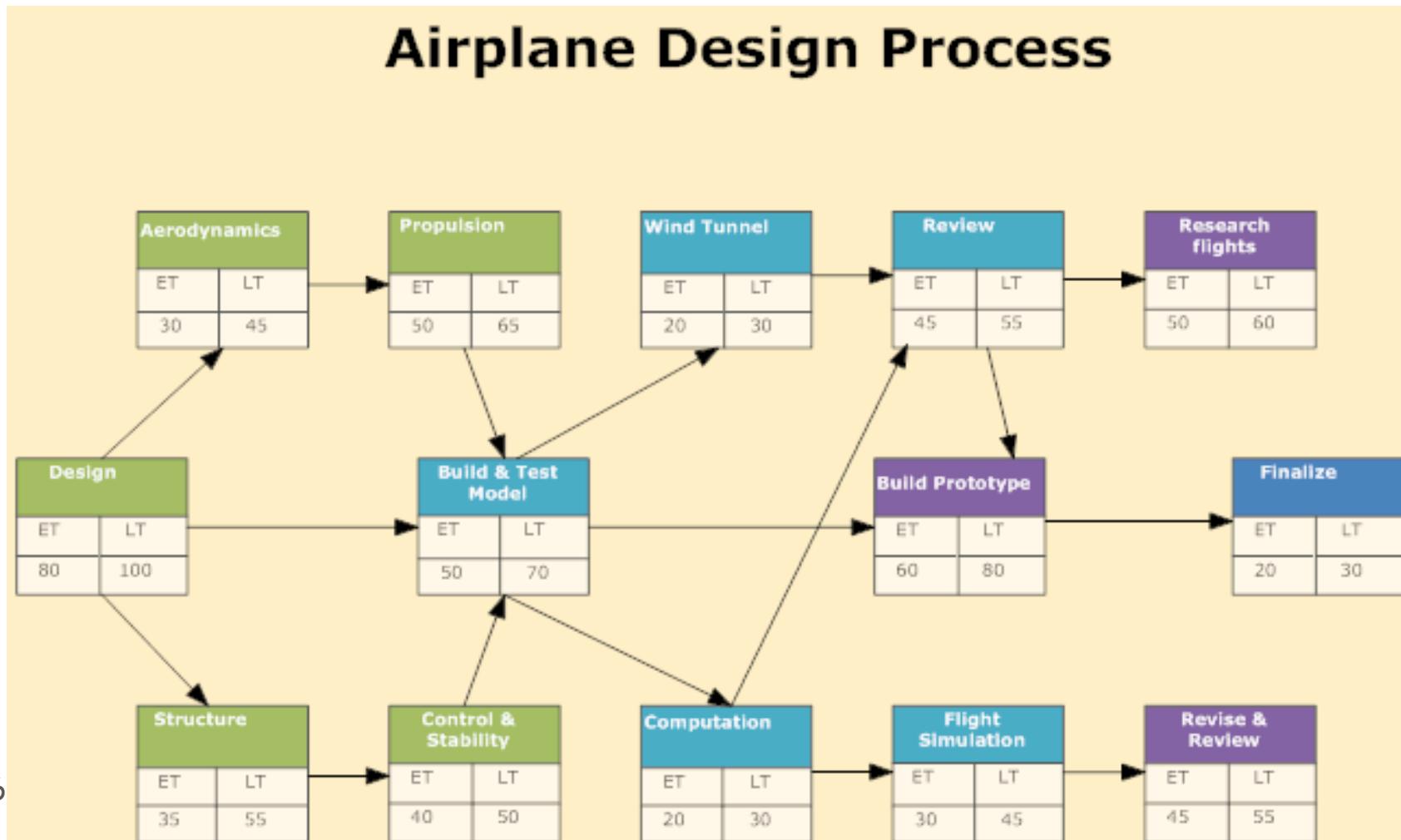


- Project (write software, design/build plane, hire new person) involves
  - Multiple steps
  - Spread over *time*
  - Some steps depend on other steps
- How can we plan/manage project?
- With PERT/Gnatt/CPM charts, of course ☺

# PERT Chart - Time Dependencies



- PERT = Project Evaluation and Review Technique

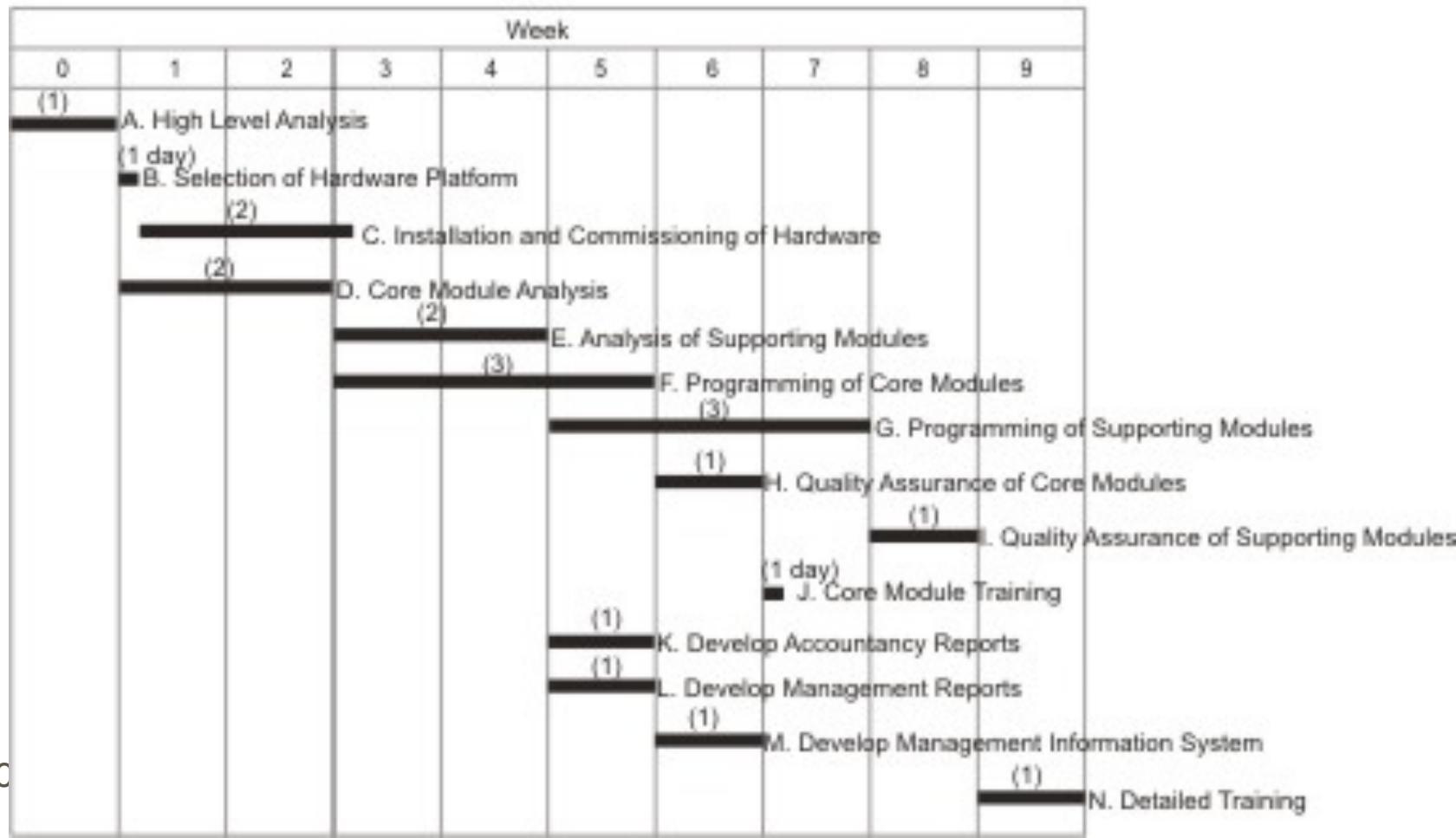


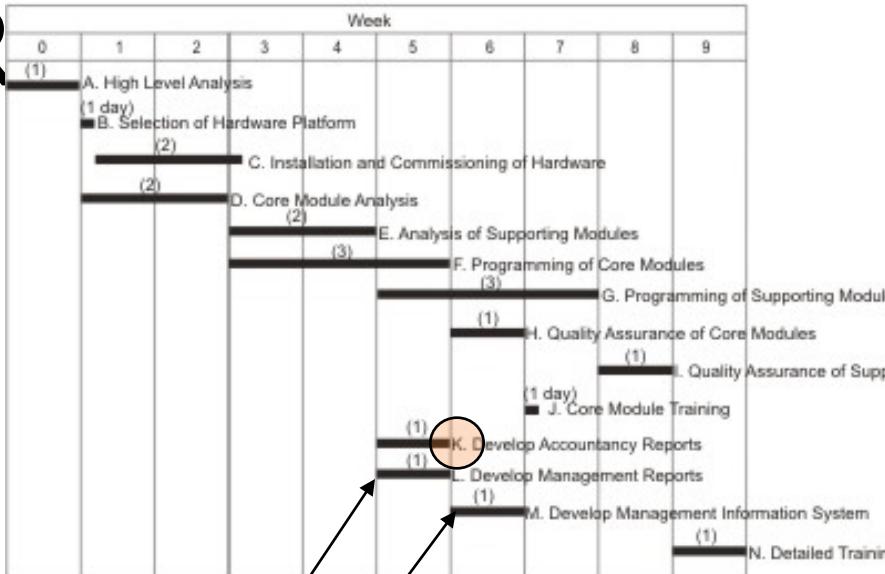
# PERT leads to Gnatt



- Dependencies on time-line

Figure 2: Draft Gantt Chart: Example Computer Project

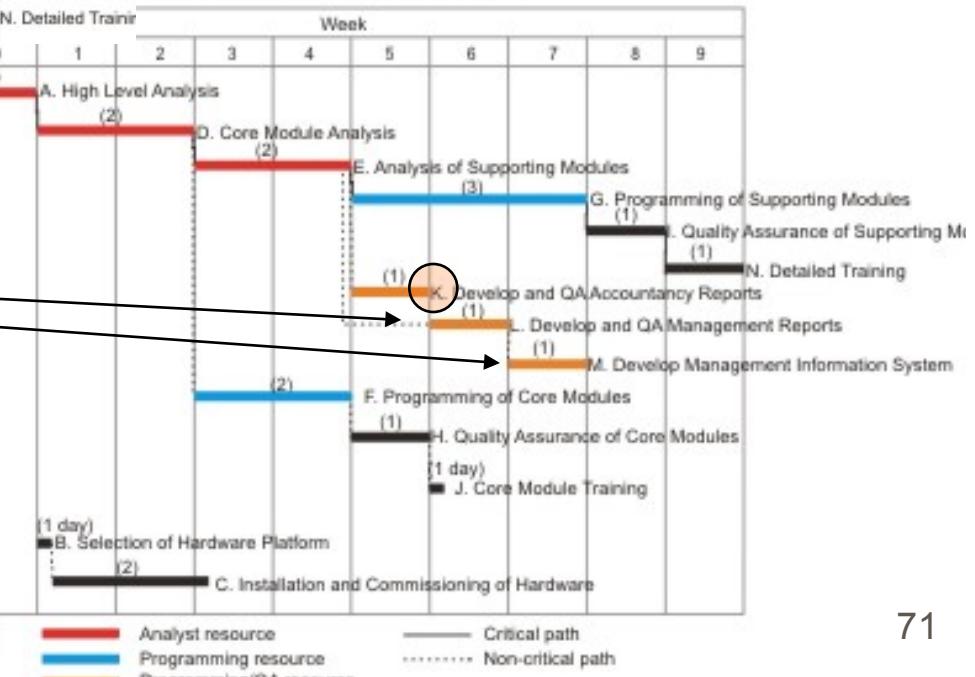


**R**

Activities L & M delayed by a week so same person can do activity K

## Shows

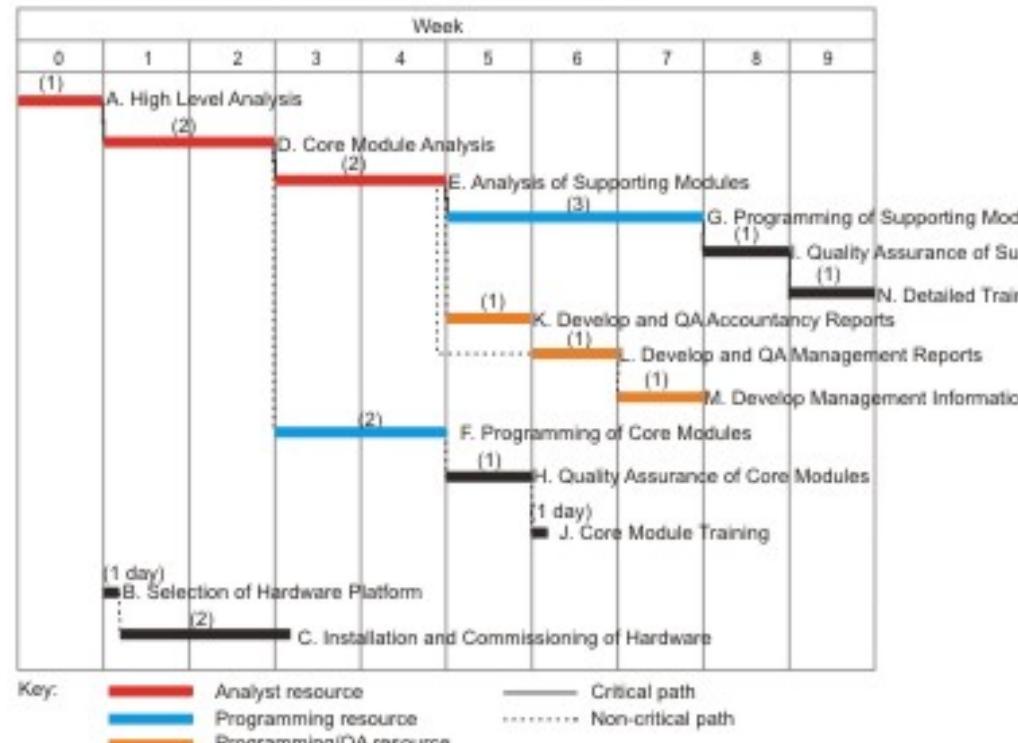
- Resources (colors)
- Critical path activities



# Revised Gnatt Chart Tells Us That



- Ten week completion **IF** all goes well
- Completion in ten weeks requires:
  - 1 analyst for the first 5 weeks
  - 1 programmer for 5 weeks starting week 4
  - 1 programmer/QA expert for 3 weeks starting week 6
- Analysis, development and testing of supporting modules must be on time.
- Hardware not time-critical but must complete before Core Module Training start



From [http://www.mindtools.com/pages/article/newPPM\\_03.htm](http://www.mindtools.com/pages/article/newPPM_03.htm)

# Many Project Mg't Products!

PTCL WBH Project Plan 0.1 - [Compatibility Mode] - Microsoft Project (Technical Preview)

Gantt Chart Tools

Task Resource Project View Format

Cut Copy Arial 8 Mark on Track Respect Links Inactivate

Paste Format Painter Clipboard Font Tasks

Manually Schedule Auto Schedule Move Task Inspect Task Task Mode Task Summary Milestone Deliverable Insert Task Information Details Add to Timeline Properties Scroll to Task Fill Editing

Task Name Duration Start Finish

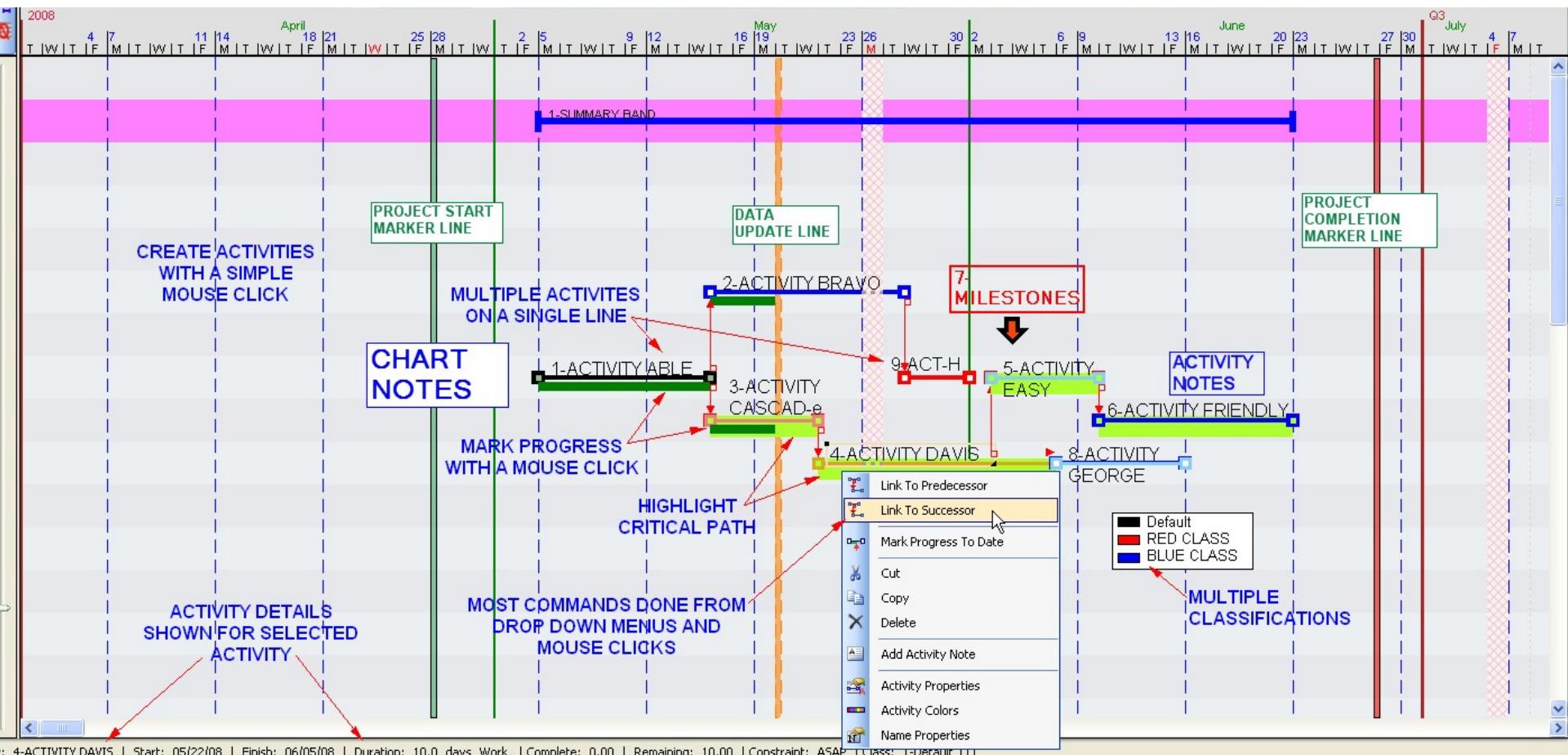
	Task Name	Duration	Start	Finish
4	+ Site Architecture	1.5 days	Fri 9/7/07	Mon 9/10/07
8	+ Domain Controllers	1 day	Mon 9/10/07	Tue 9/11/07
10	- MPS	6 days	Tue 9/11/07	Wed 9/17/07
11	MPF and SQL	1 day	Tue 9/11/07	Wed 9/12/07
12	Web services	1 day	Wed 9/12/07	Thu 9/13/07
13	Service Plans	1 day	Thu 9/13/07	Fri 9/14/07
14	WSS Provisioning	1 day	Fri 9/14/07	Mon 9/17/07
15	Sitebuilder provisioning	2 days	Mon 9/17/07	Wed 9/19/07
16	+ WSS	1.5 days	Wed 9/19/07	Thu 9/20/07
19	+ Web Hosting	6 days	Fri 9/21/07	Fri 9/28/07
23	+ Data Hosting	4 days	Mon 10/1/07	Thu 10/5/07
26	+ File Server Design	2 days	Fri 10/5/07	Mon 10/8/07
29	+ Infrastructure services	3 days	Tue 10/9/07	Thu 10/11/07
36	+ Antivirus	1 day	Fri 10/12/07	Fri 10/12/07
39	Disaster Recovery Site	5 days	Mon 10/15/07	Fri 10/19/07
40	Stress test design	2 days	Mon 10/22/07	Tue 10/23/07
41	- Development	43 days	Fri 9/7/07	Wed 10/31/07
42	+ Ensim Panel integration	15 days	Fri 9/7/07	Fri 9/28/07
43	MySQL provisioning in WBH 4.5	8 days	Fri 9/28/07	Wed 10/10/07
44	SiteBuilder Provisioning	10 days	Wed 10/10/07	Wed 10/24/07
45	inactive accounts inactivation	5 days	Wed 10/24/07	Wed 10/31/07
46	account deletion	5 days	Wed 10/31/07	Wed 11/6/07
47	+ Implementation	47.5 days	Wed 10/24/07	Fri 11/6/07
48	+ Domain Controllers	1 day	Wed 10/24/07	Wed 10/24/07
49	Active Directory	1 day	Wed 10/24/07	Wed 10/24/07
50	+ MPS	4 days	Thu 10/25/07	Tue 10/30/07
54	+ Infrastructure services	5 days	Wed 10/31/07	Tue 11/6/07
55	+ MOM 2005	4 days	Wed 10/31/07	Mon 11/5/07
56	MOM Database setup	0.5 days	Wed 10/31/07	Wed 11/1/07
57	MOM and reporting Setup and Installation	2 days	Wed 10/31/07	Fri 11/2/07
58	Agent installation	0.5 days	Fri 11/2/07	Fri 11/2/07
59	Alerts and notifications Setup	1 day	Mon 11/5/07	Mon 11/5/07
60	Wsus	1 day	Tue 11/6/07	Tue 11/6/07
61	+ WSS	2.5 days	Wed 11/7/07	Fri 11/9/07

Microsoft Project

Ready New Tasks : Auto Scheduled

9:40 PM  
6/7/2009

# One from Georgia Tech



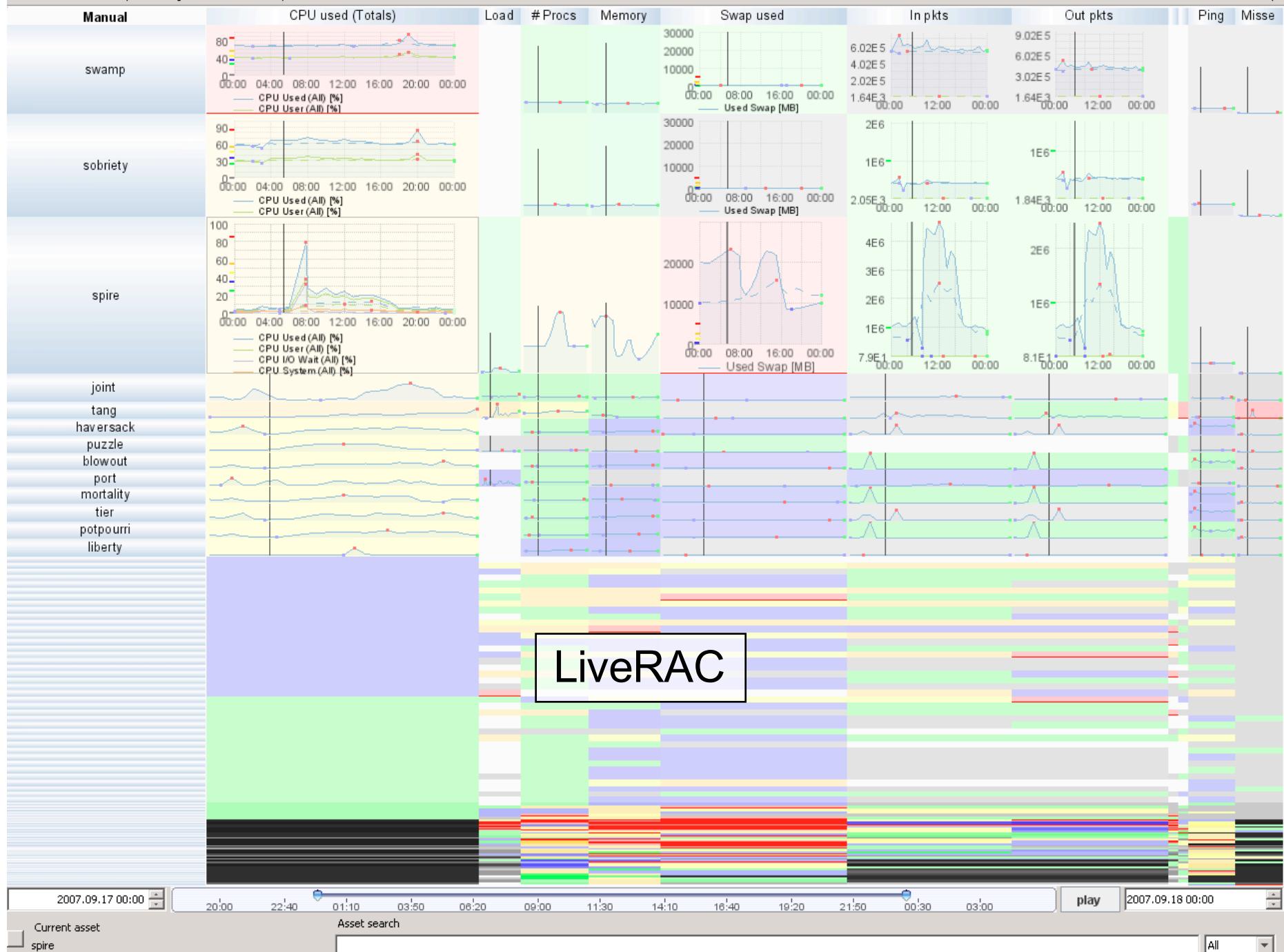
# Example: Monitor Computer Systems

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- This system (LiveRAC) Supports review of continuous data and real-time monitoring
- MieLog example is for after-the fact inspection of discrete event data
- LiveRAC was a 2.5 year, multi-person project

McLachlan, Munzner, EKoutsofios, North. *LiveRAC - Interactive Visual Exploration of System Management Time-Series Data*, CHI'08



# **LiveRAC: Interactive Visual Exploration of System Management Time-Series Data**

# LiveRAC Design Principles

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- Involve users early
- Use spatial position as perceptual cue
  - Related items are proximate (grouped)
- Use side-by-side “small multiples” to minimize load on short term memory
- Link multiple views
- Animate changes – no abrupt transitions
- Immediate feedback
- Use graph styles with which users are already familiar
- Overview first, zoom and filter, details on demand
- Assertion: Several levels of detail side-by-side
  - Why given as assertion rather than principle?
  - Seems like a principle to me ☺ - giving context along with detail