More on Time

CS 4460 - Information Visualization
Jim Foley

Some PPts from Prof. John Stasko.

Last revision: October 2016

A Taxonomy of Time Data

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

- 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

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

- More on next pages…….

Time Series Examples

- 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?
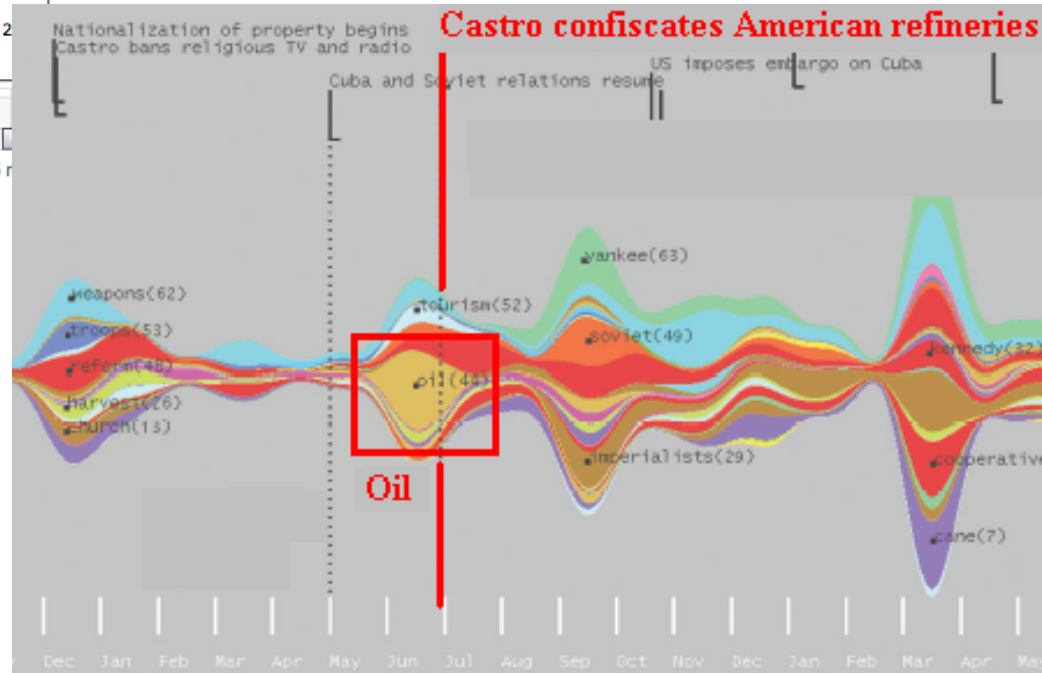
    How good for comparing multiple time series?

Examples

https://eresearch.fidelity.com/eresearch/evaluate/snapshot.jhtml?symbols=AAPL

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Discuss

- 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

- 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
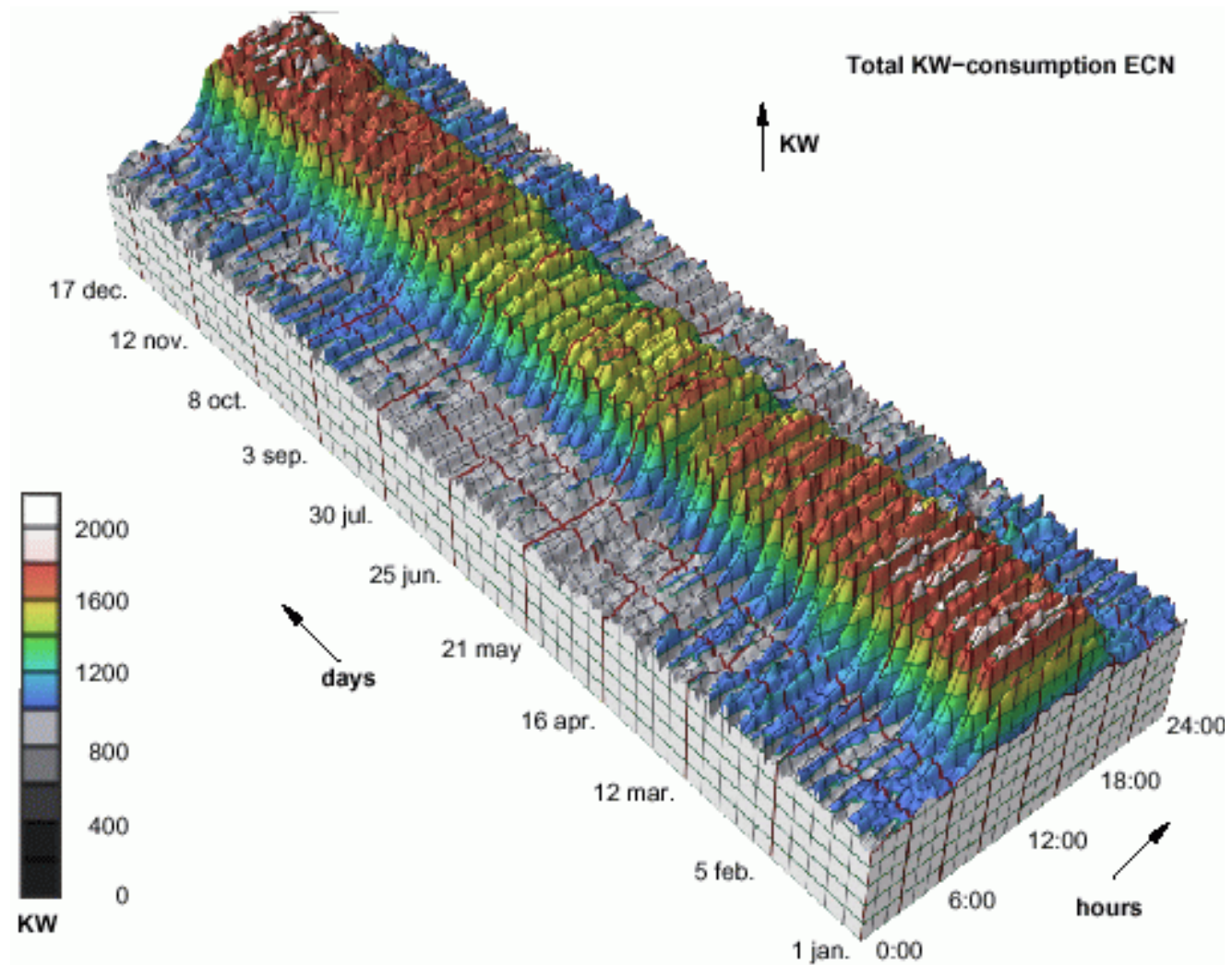   - Idea applies beyond this example

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
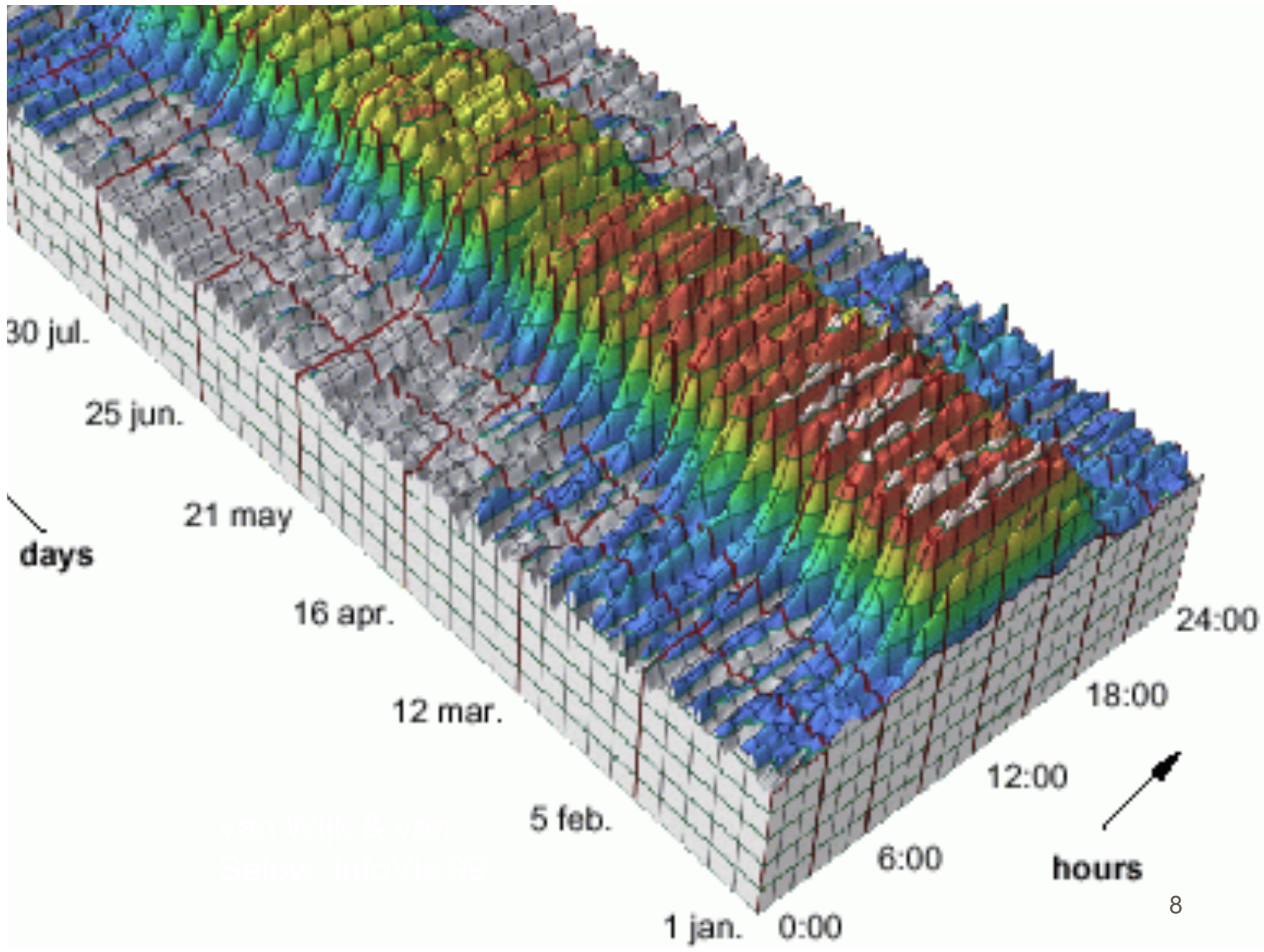
Total KW-consumption ECN

30 jul.

25 jun.

21 may

days

16 apr.

12 mar.

5 feb.

1 jan.   0:00

6:00

12:00

18:00

24:00

hours

8

Discuss

- 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?

Use 'Cluster Analysis'

- 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

- Widely-used method
- Defining 'close' is key
  - Varies from one domain to another
  - Text - count differences – key words, tags
  - Pictures –look at features of some sort
  - 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
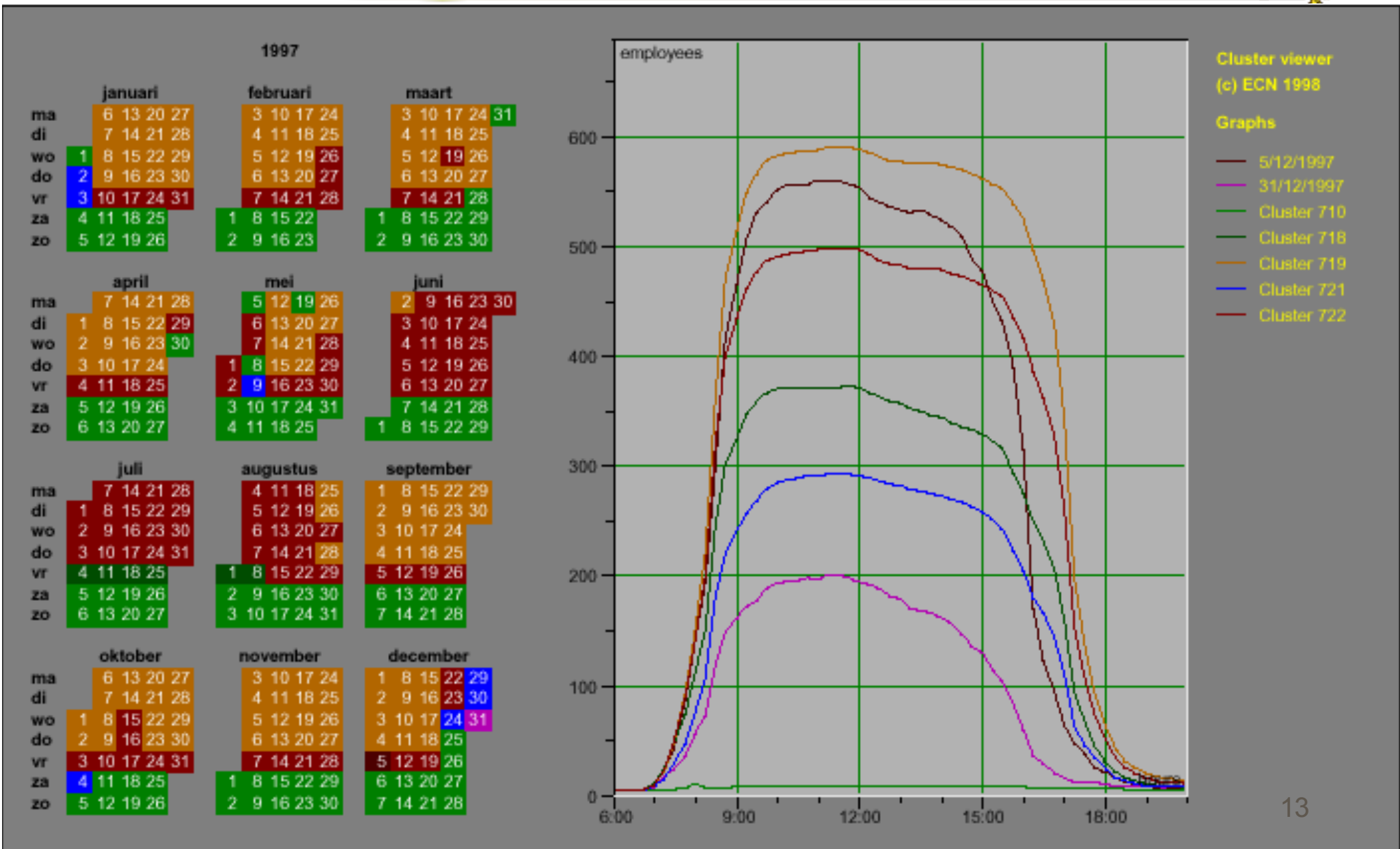
    Why use absolute value of Δ_i ?

An Aside - Dendogram

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

Stop here if
want 5 clusters

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Cluster Display – People at Work

13
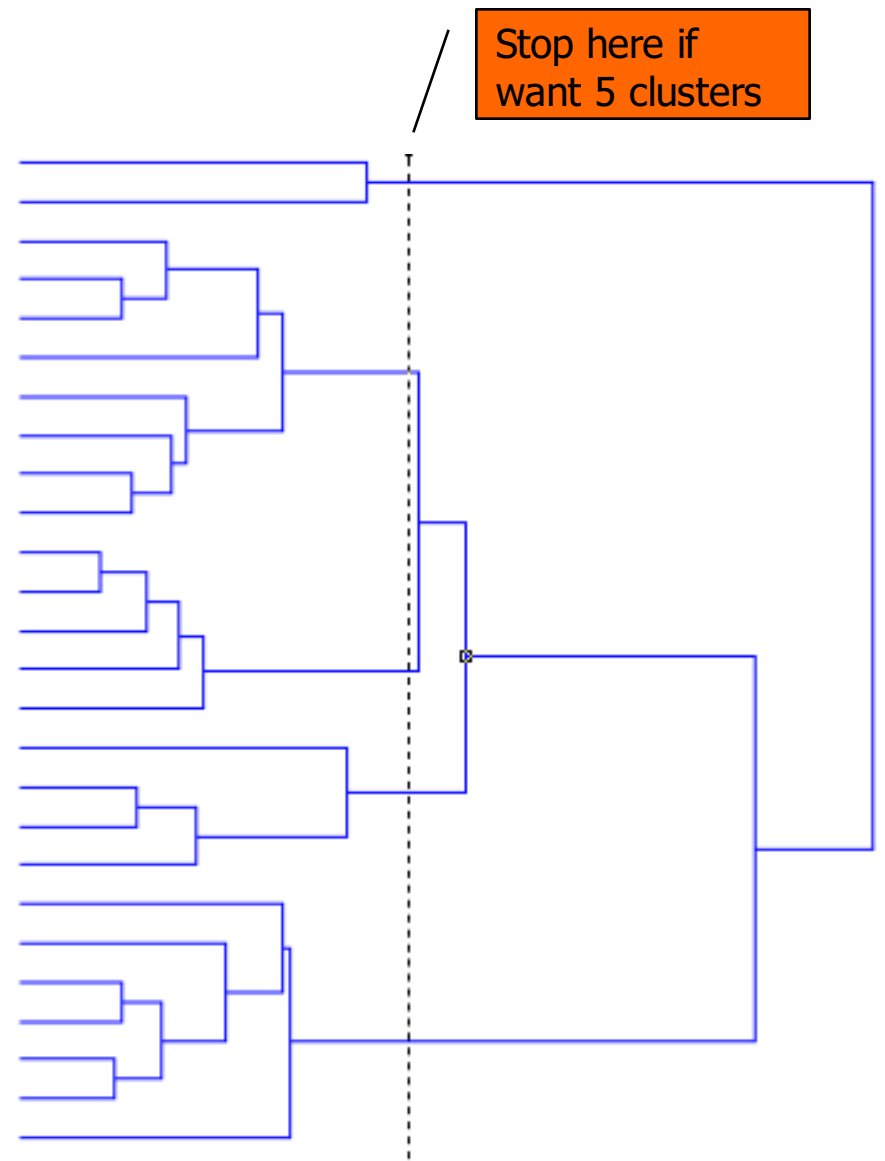
Cluster Display – People at Work
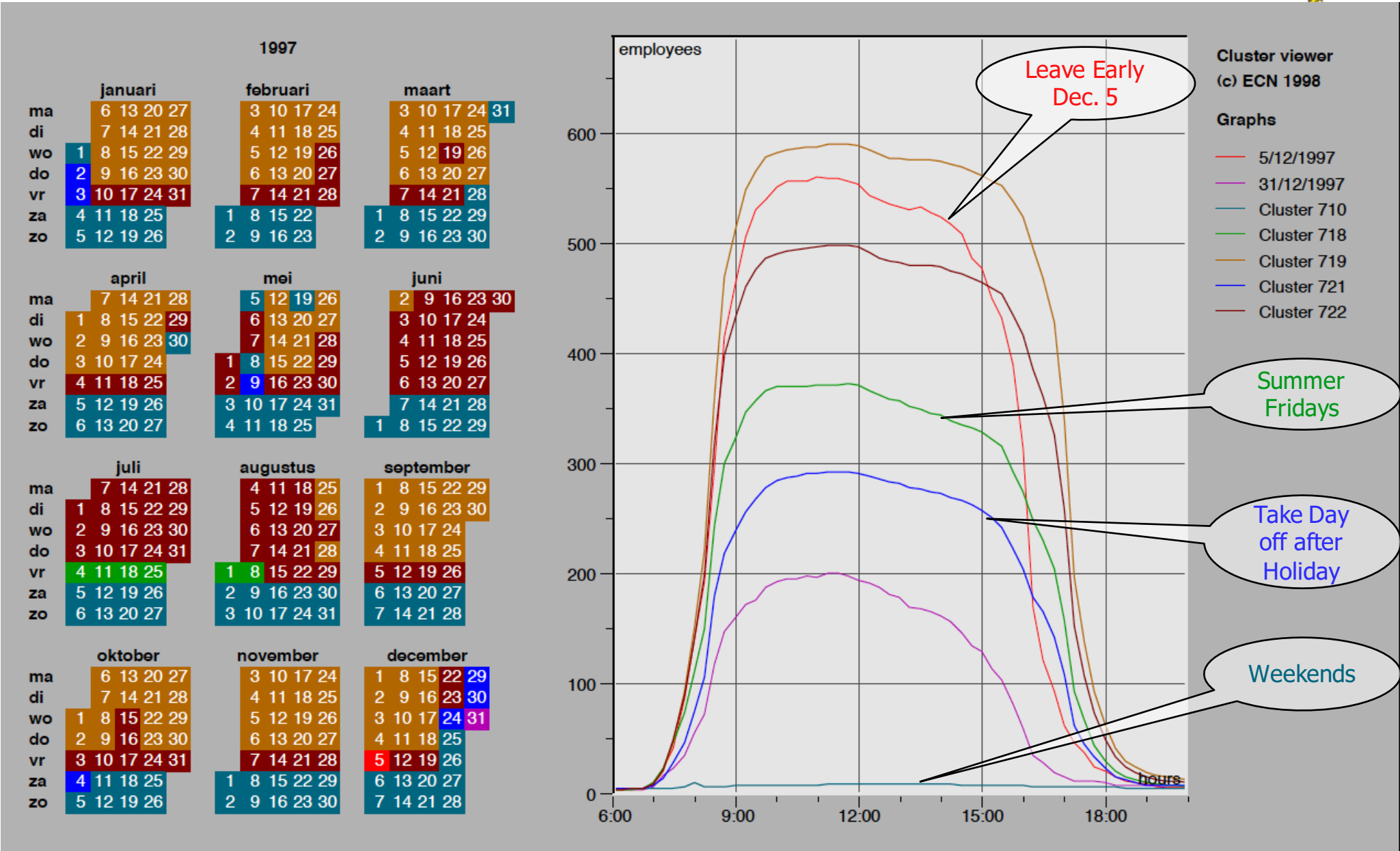
What Cluster Display Shows Us

- Traditional office hours are 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
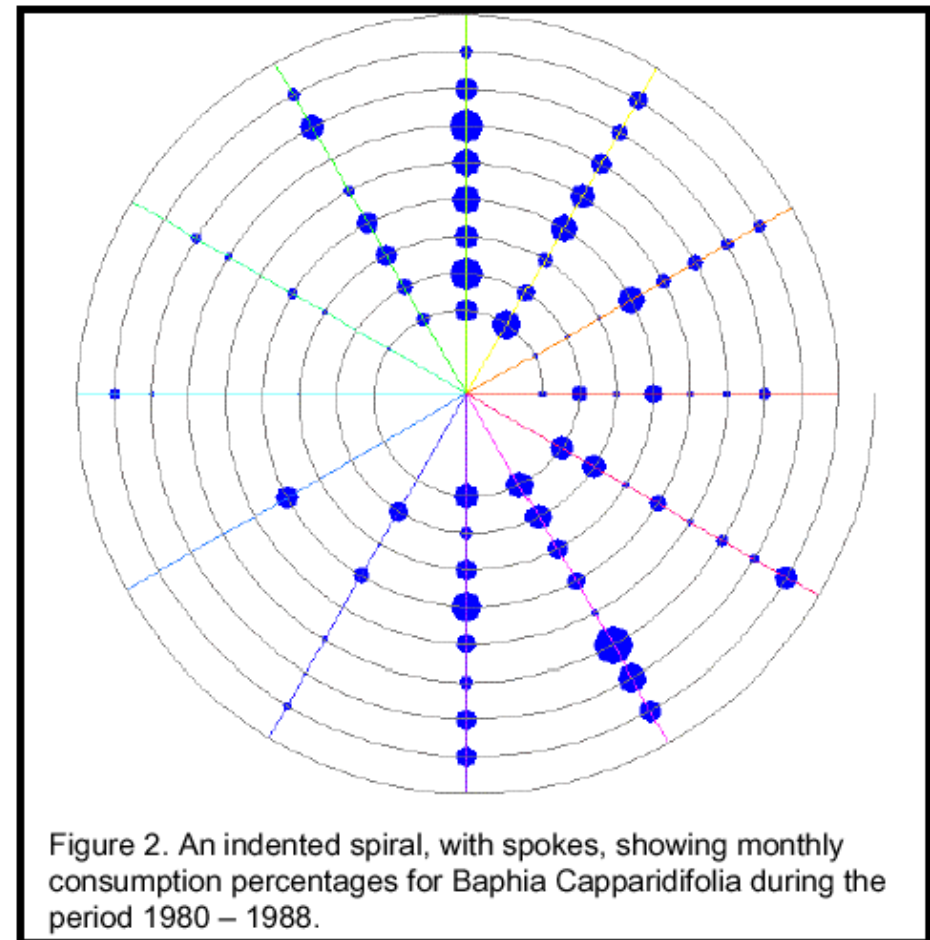 - One loop is one period
  - What if data NOT periodic?
- Time line becomes the spiral
  - Avoid problem of long time line
  - *Could use concentric circles instead of spiral*

Figure 2. An indented spiral, with spokes, showing monthly consumption percentages for Baphia Capparidifolia during the period 1980 – 1988.

Konstan and Carlis, *Interactive Visualization of Serial Periodic Data*, UIST '98; data set is chimpanzee food consumption.

Add Third Dimension for More Data

Multiple values per point

Small multiples; one value per point
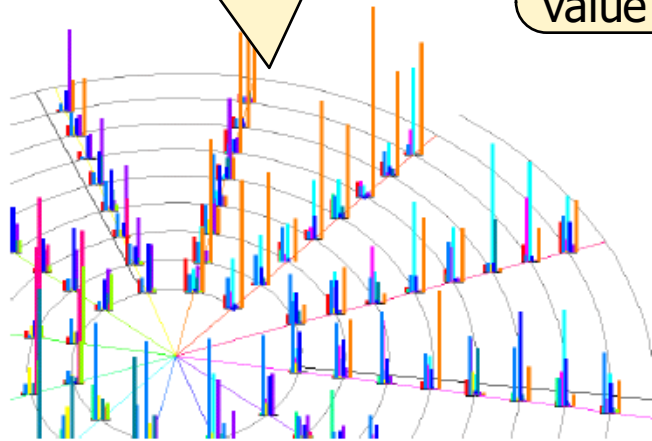
Mini bar-chart at each point
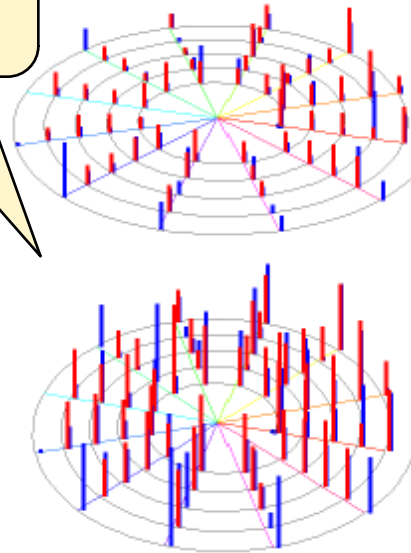
Two linked spirals:

2 chimpanzees

group avg size & max size
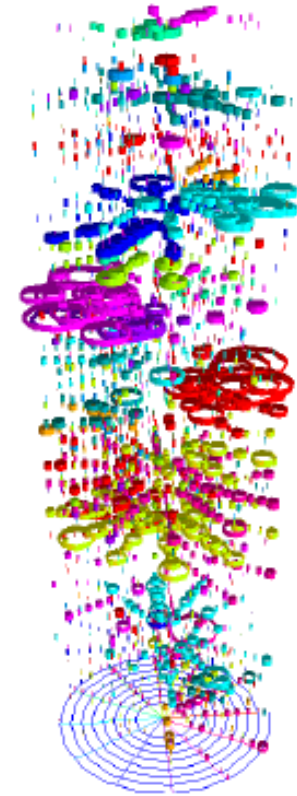
112 food types

Useful? ☺

Discuss

- What type of time data shown?
- When useful?
- How much info is visually coded?
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- How good for comparing multiple time series?

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 »
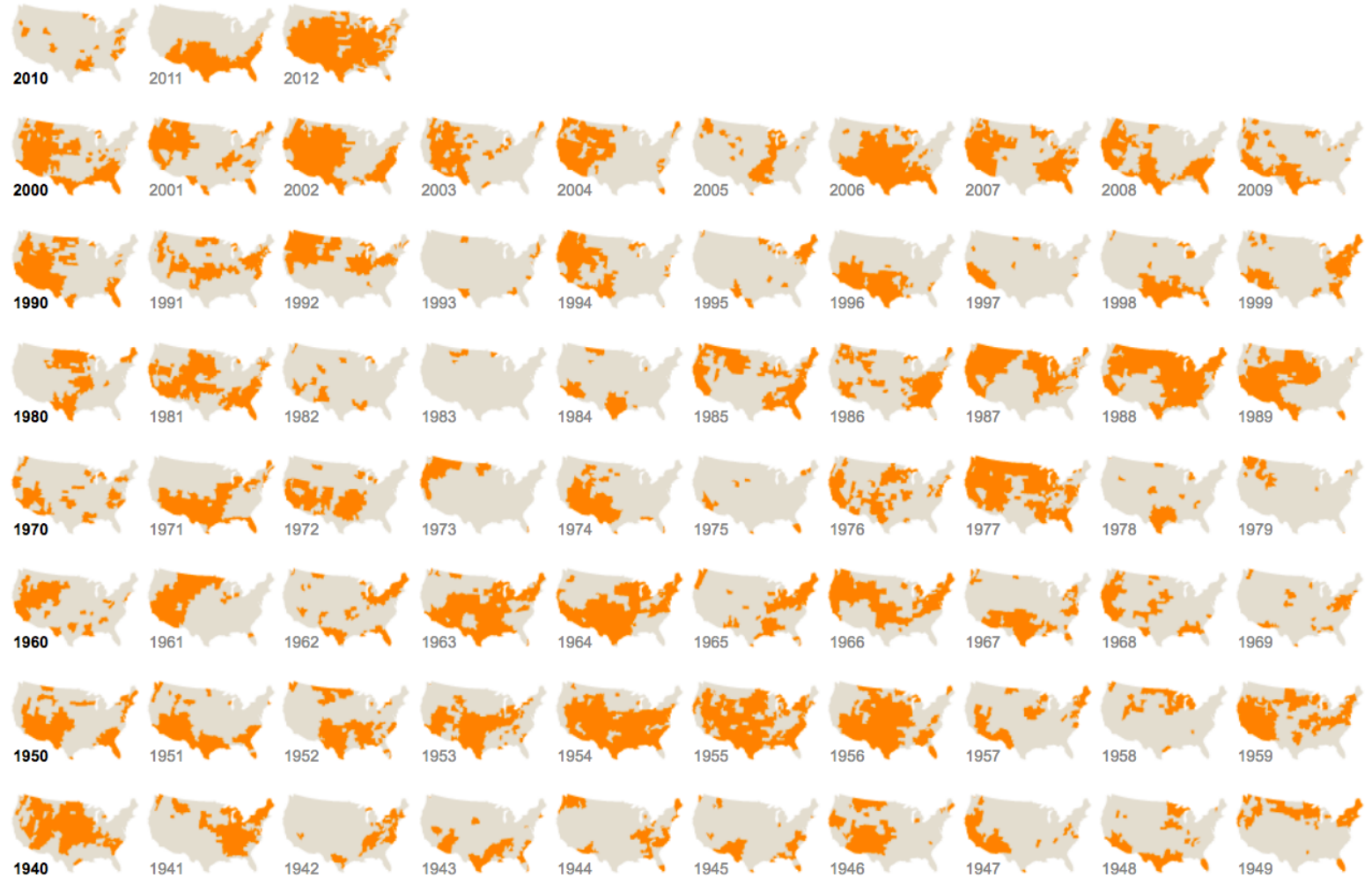
Time in 2D

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.
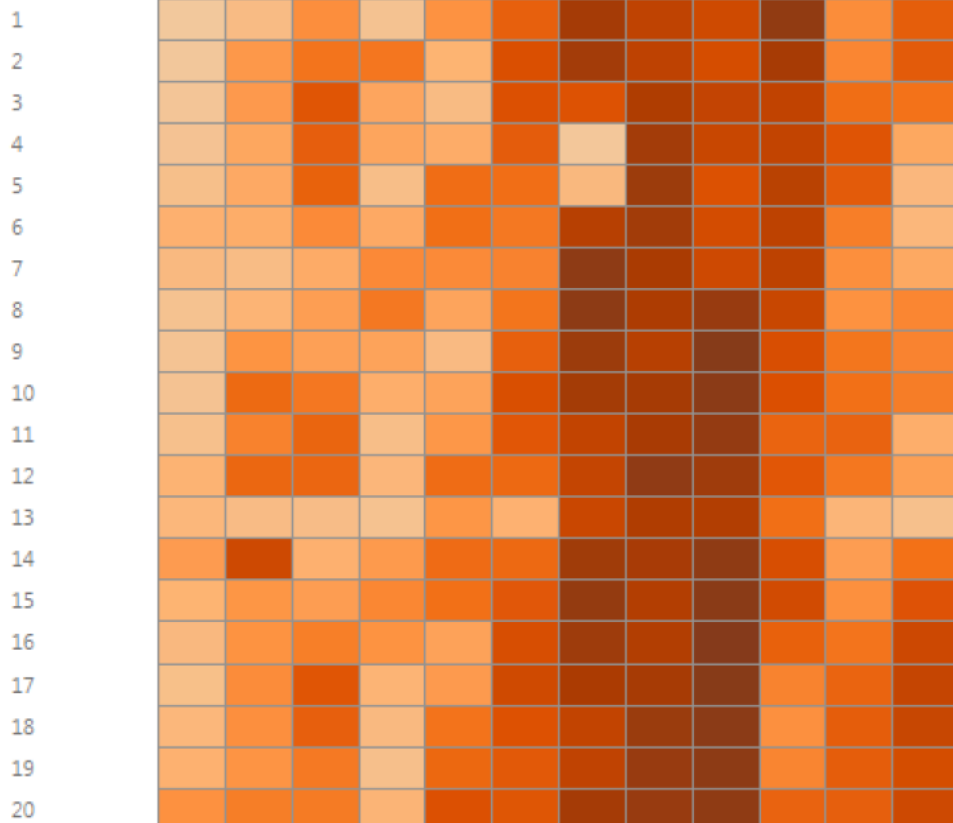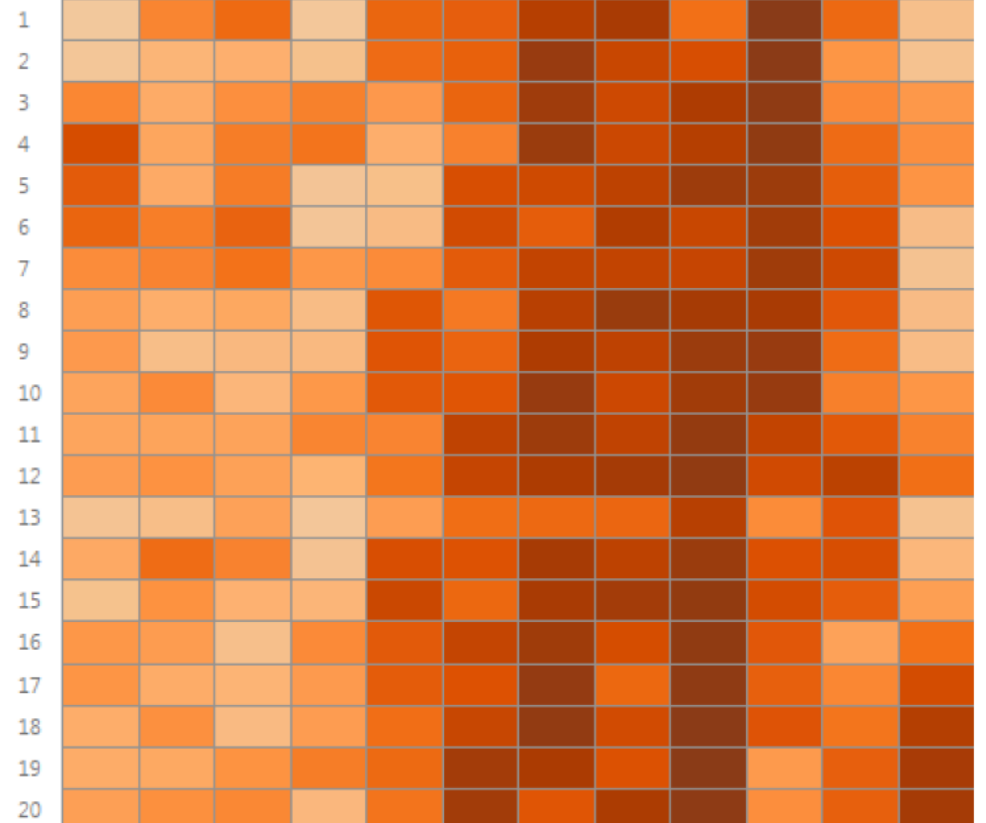
Time via Parallel Coordinates

2013 BCS College Football Rankings
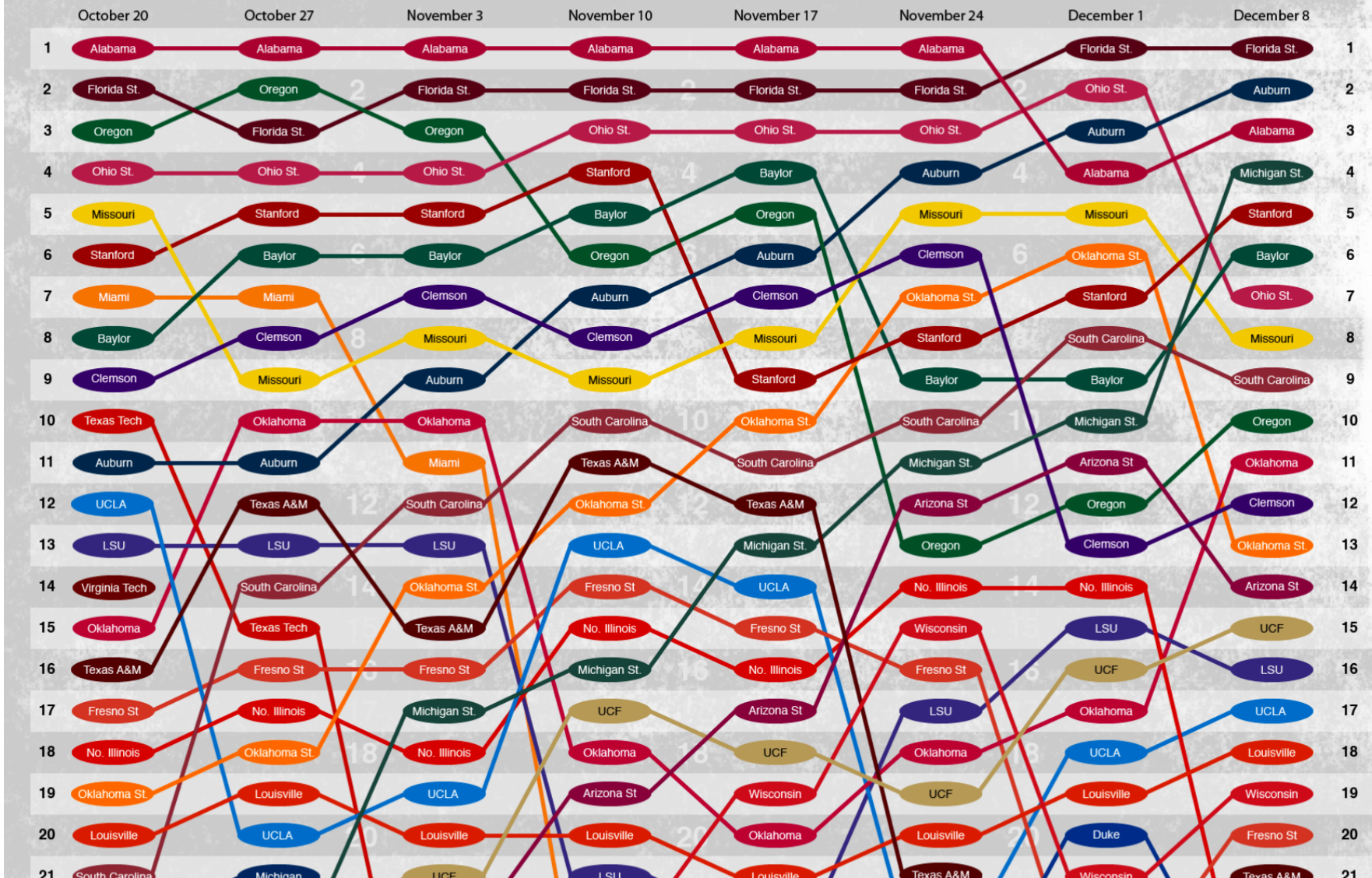
Design Exercise

- 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 ☺

Visualizing Time Intervals

1. Prostrate cancer progression
2. TimeSpan
3. Meeting discussions
4. Music over time
5. Story Lines
6. PERT Charts

1. Prostate Cancer Progression

2. TimeSpan

https://vimeo.com/143162420
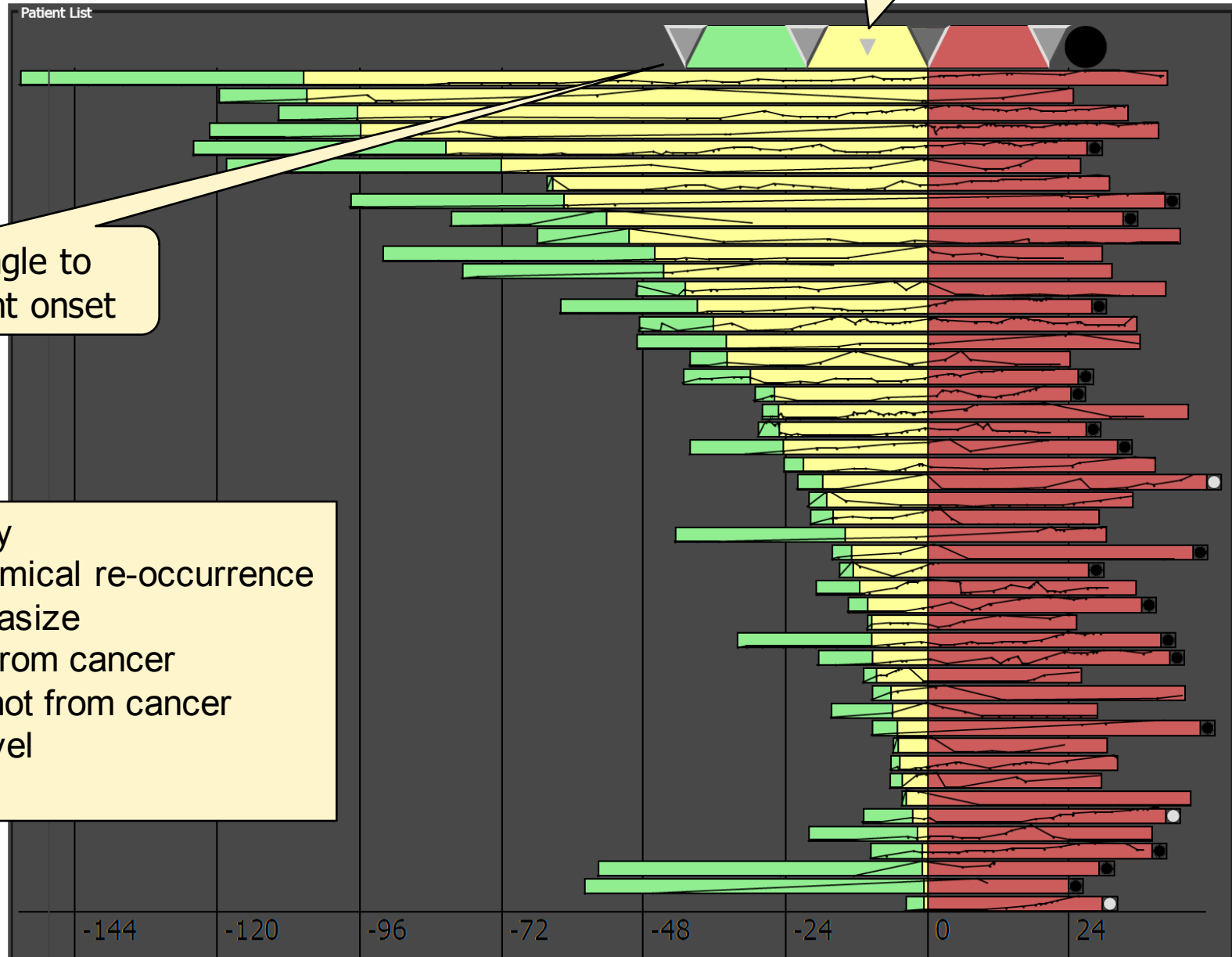
More refined view of all cases

tPA to Endo

CT to tPA

Door to CT

Dispatch to Door

Onset to Dispatch

Individual case DoD

Overview of all cases

Histogram

Loorak et al, TimeSpan: Using Visualization to Explore Temporal Multi-dimensional Data of Stroke Patients, IEEE Transactions on Visualization and Computer Graphics (Volume: 22, Issue: 1, Jan. 31 2016)
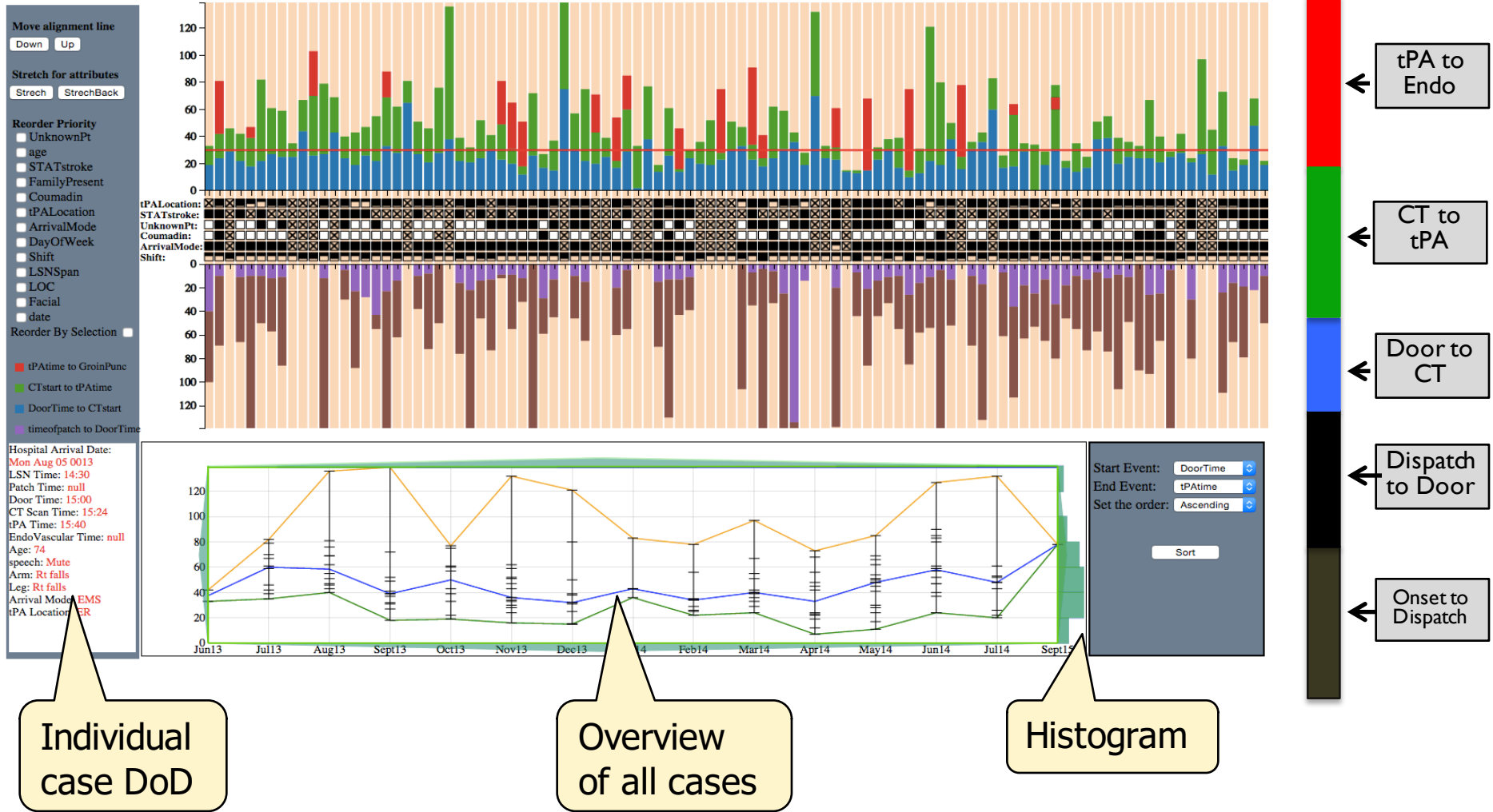
3. Meeting Discussions

Alallah et. al, *Visualizing the Decision-making Process*,
11th International Conference on Information Visualization (IEEE InfoVis 2007)

Adapted from a CS4460 presentation by Dylan Demyanek, William Harris and Kristina Makarova

Legend (left box):
- Hiring managers
- Shares issue
- Marketing improvements
- Widget product process
- New corporation establishment
- New polices

Participants:
Dean
Fouad
Mahtab
Andrea
Jennifer
Gina
Michelle
Katherine
Bill
Sophei

Agenda

De...
yes/n...
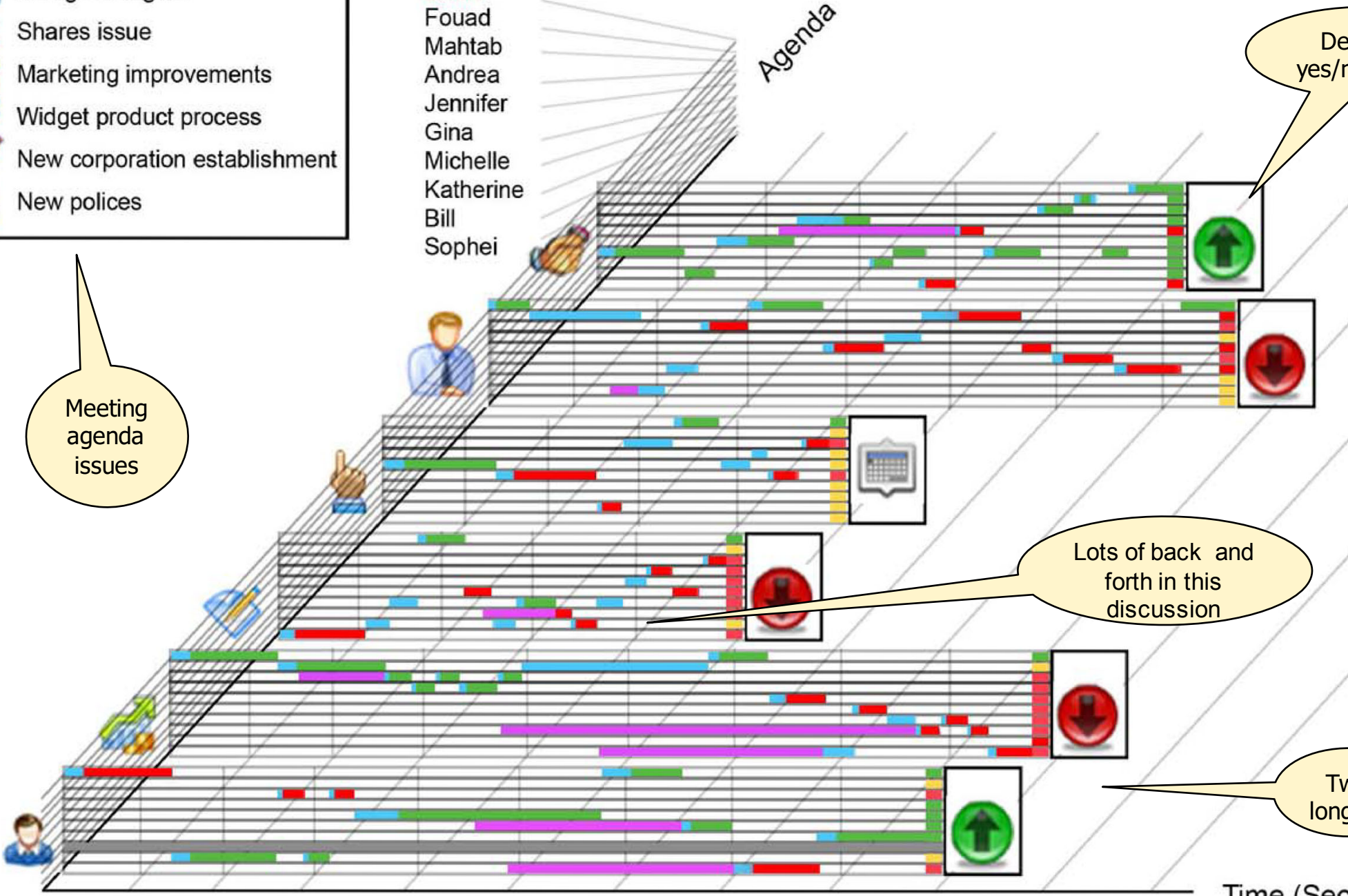
Meeting agenda issues

Lots of back and forth in this discussion

Tw...
long...

Time (Sec...

120 240 360 480 600 720 840 960 1080 1200 1320

Time Line Close-up

Dean and Fouad took up most of the discussion as seen by the length of the bars.

Decision of each individual regarding the agenda topic.

The final decision for this agenda is disagreed as depicted by the icon.

Participants
Dean
Fouad
Mahtab
Andrea
Jennifer
Gina
Michelle
Katherine
Bill
Sophei

120   240   360   480   600   720   840   960   1080   1200

Time (Seconds)

After 400 seconds of starting the meeting, Katherine asks to wait in the queue. She waits for 510 seconds (8.5 minutes) before she takes her turn to speak.

Collaboration among some participants is noticeable as they are leaning on the same side of the decision.

Individual activities

- 🟩 Speaking for
- 🟥 Speaking against
- 🟦 Speaking not decided
- 🟪 Queued to speak
- ⬜ Attending
- ⬛ Not attending

Individual decision

- 🟩 Agreed
- 🟥 Disagreed
- 🟨 Abstain

Group decision

- 🟢 Agreed
- 🔴 Disagreed
- 🖥 Deferred

Meeting name: Meeting No.13, Date: December, 9th, 2006, Location: E2-460, Purpose: Annual meeting

Critique me!
Make me better!
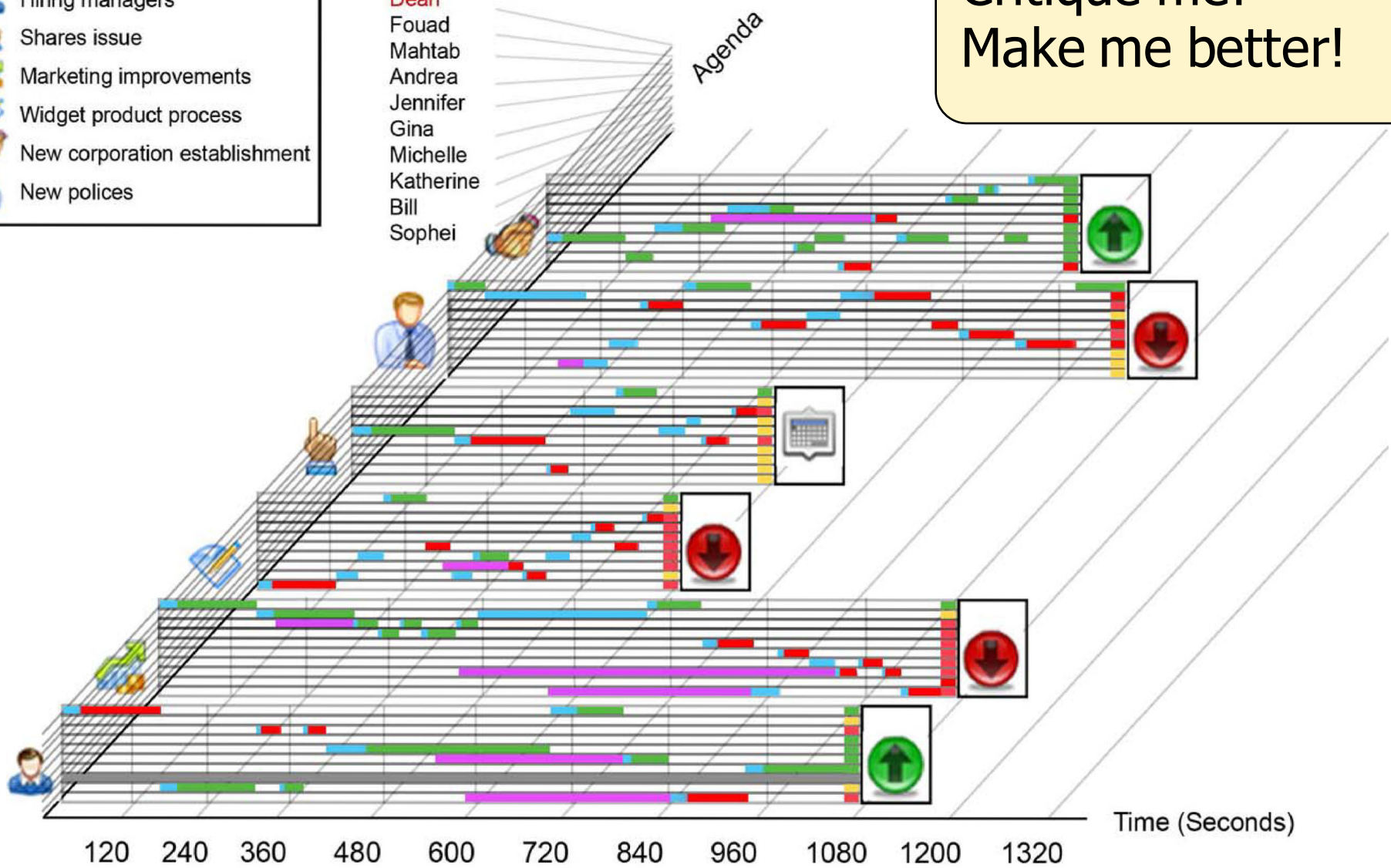
4. Music Over Time

History of Genres   http://rockhall.com/timeline/   (dead link)

http://www.rockhall.com - The History And Heritage Of Rock and Roll - Microsoft Inter...

all genres   zoom

| 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 |

PHIL SPECTO
SOUL
MOTOWN
DEEJAYS   FUNK   NEW ROMANT
CHESS REC   SINGER-SONGWRITER
COUNTRY   INDIE LABELS   FOLK ROCK
RHYTHM & BLUES
GOSPEL
BLUES
FOLK MUSIC   INSTRUMENTAL ROCK   TECHNO
ATLANTIC RECORDS   INDIE ROCK
TEEN IDOLS   MTV
NEW ORLEANS SOUND   PROGRESSIVE ROCK
ROCKABILLY   PUNK   GRUNGE
DOOWOP   HEAVY MET HEAVY MET BRITISH POP
SURF MUSIC GLAM ROCK
BRILL BUILD SOUTHERN R
BRITISH INV DISCO
GIRL GROUPS

social context

SEARCH RESULTS   DELETE   ALL SEARC

30

5. 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 $t=0$, duration $d=4$
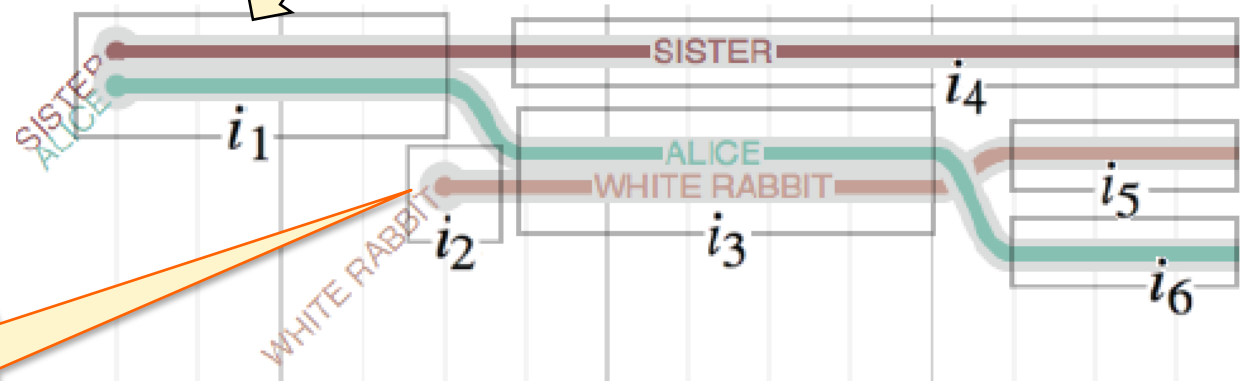
White rabbit enters at $t=4$, joins Alice at $t=5$ for $d=5$

- Design Considerations for Optimizing Storyline Visualizations, Yuzuru Tanahashi and Kwan-Liu Ma, IEEE Transactions on Visualization and Computer Graphics, Dec. 2012
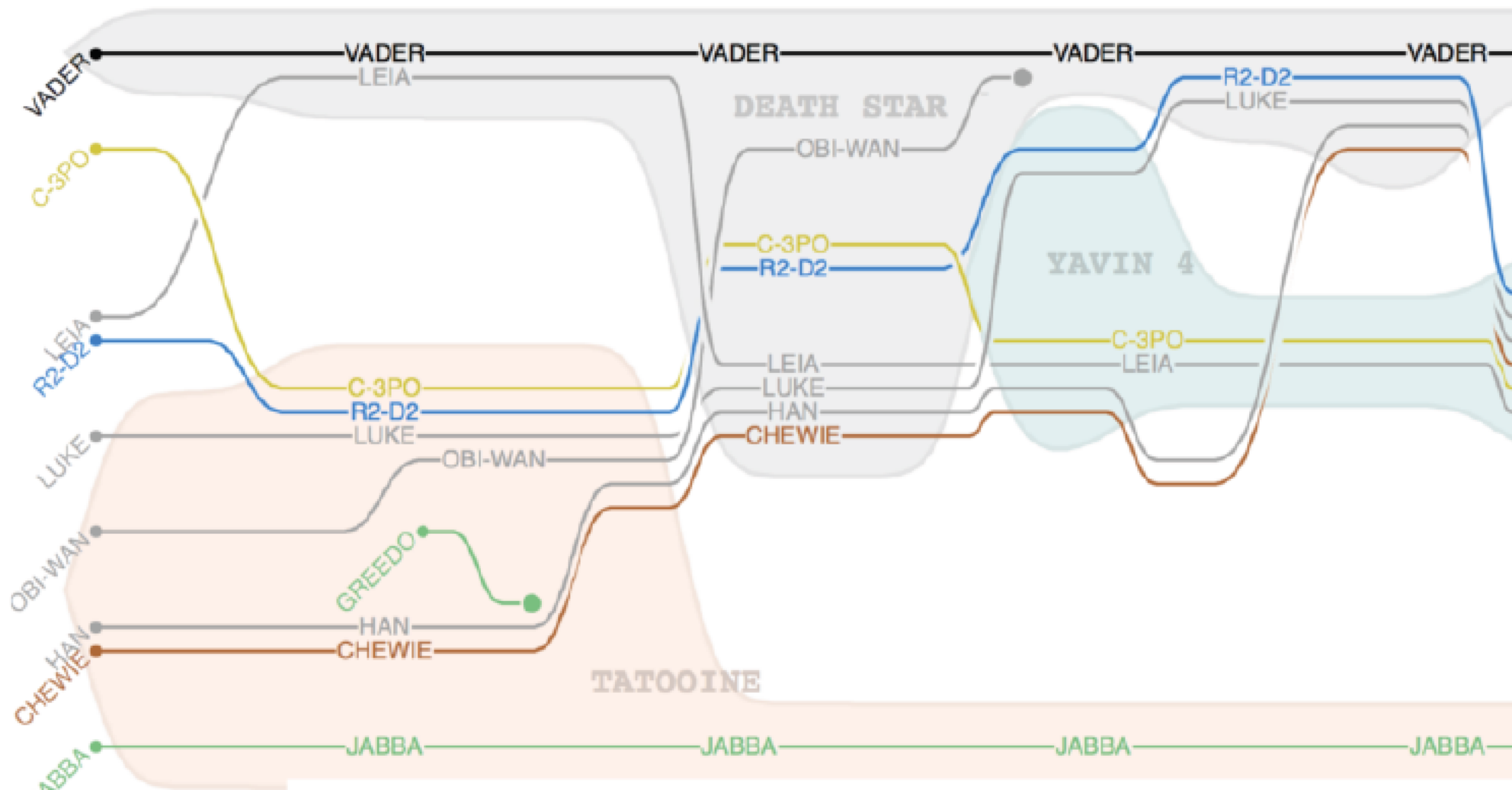
- Lines representing interacting characters must be adjacent.
- Otherwise, lines must not be adjacent.
- A line must not bend except to converge or diverge with another line.

6. PERT/Gnatt

- Project (write software, design/build plane, hire new person) involves
  - Multiple steps, each having a time interval (or range)
  - Some steps depend on other steps

PERT Chart - Time Dependencies

- PERT = Project Evaluation and Review Technique

Airplane Design Process

Gnatt Chart

Strategic Plan for New Business

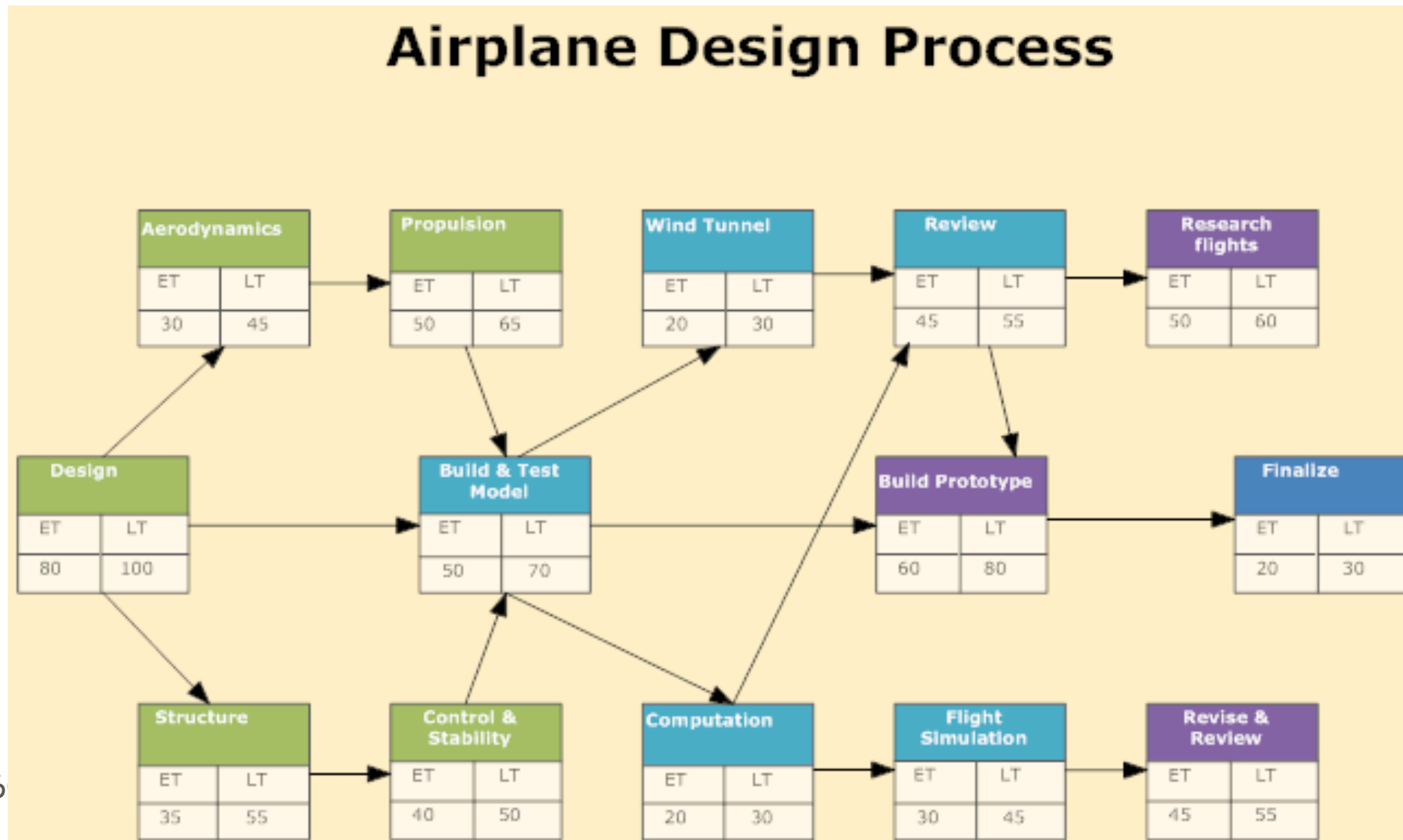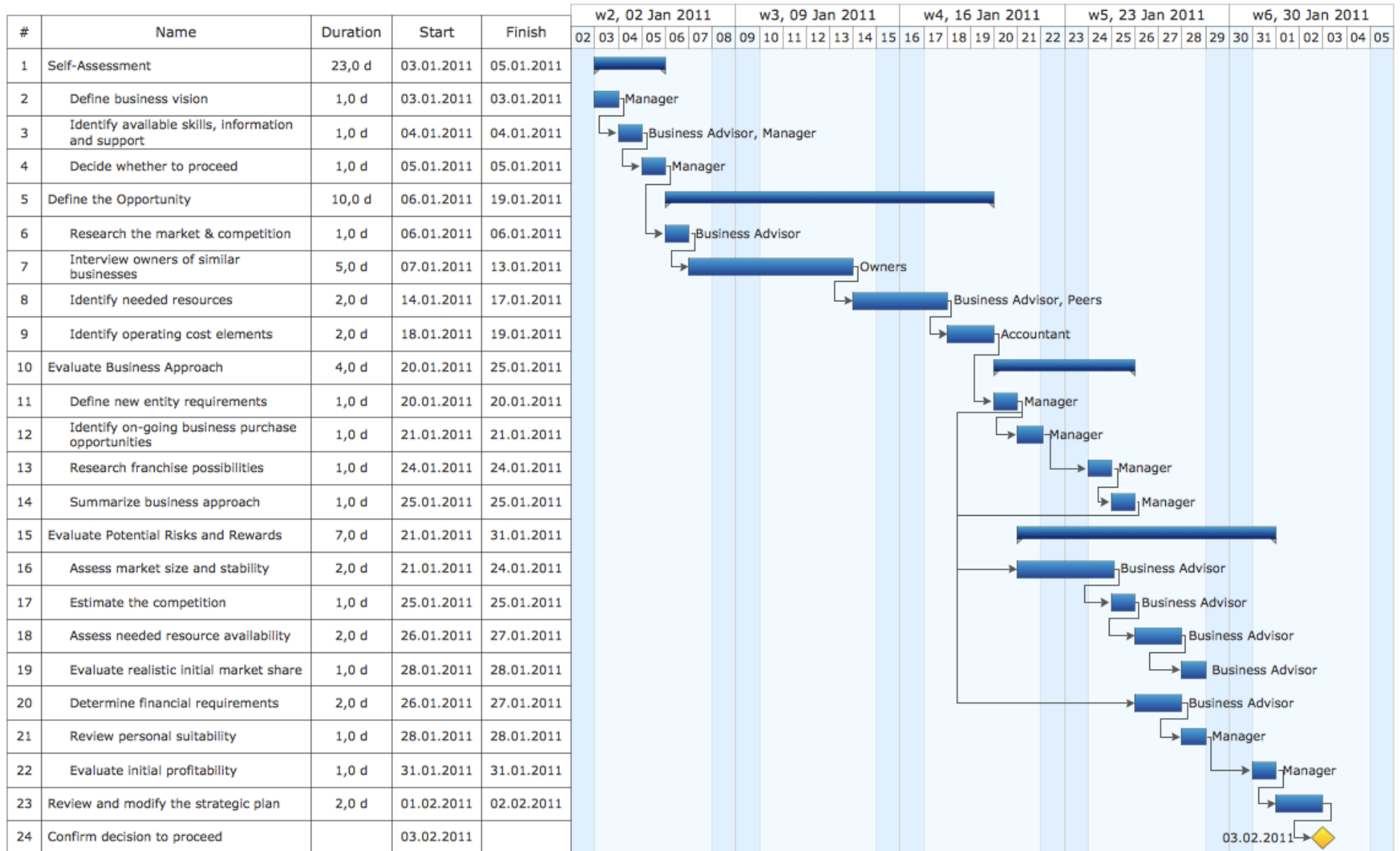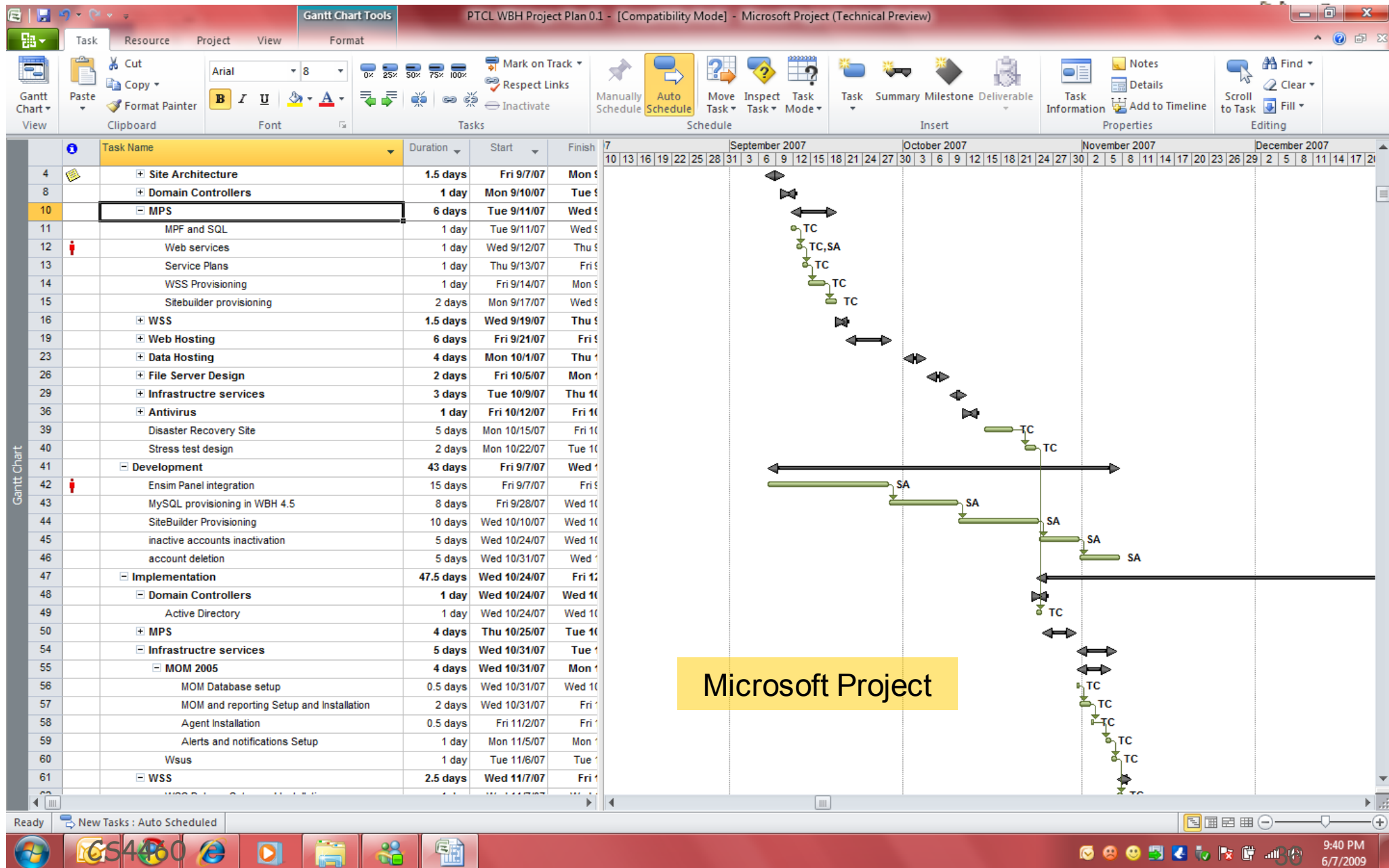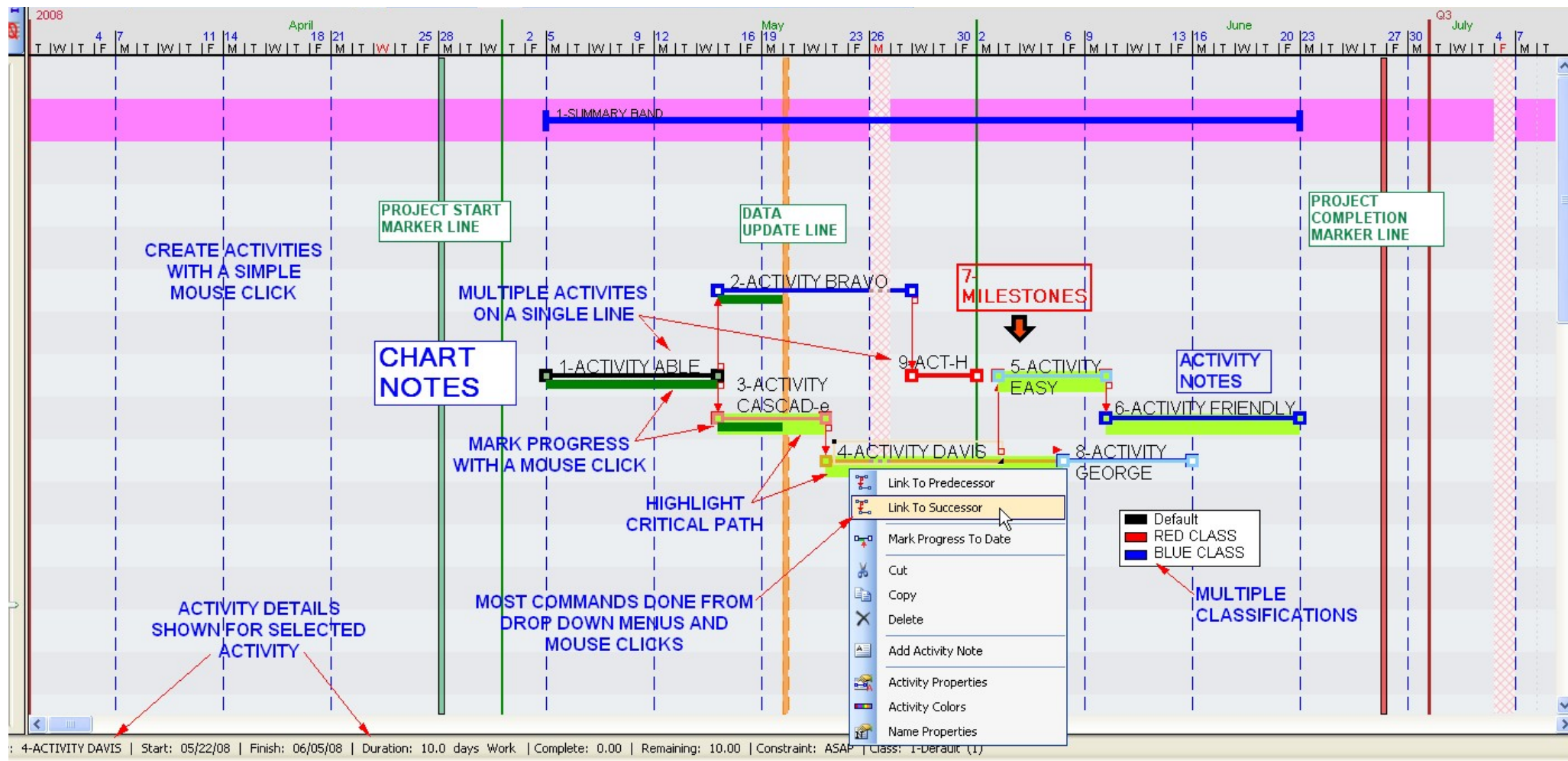| #	Name	Duration	Start	Finish
1	Self-Assessment	23,0 d	03.01.2011	05.01.2011
2	Define business vision	1,0 d	03.01.2011	03.01.2011
3	Identify available skills, information and support	1,0 d	04.01.2011	04.01.2011
4	Decide whether to proceed	1,0 d	05.01.2011	05.01.2011
5	Define the Opportunity	10,0 d	06.01.2011	19.01.2011
6	Research the market & competition	1,0 d	06.01.2011	06.01.2011
7	Interview owners of similar businesses	5,0 d	07.01.2011	13.01.2011
8	Identify needed resources	2,0 d	14.01.2011	17.01.2011
9	Identify operating cost elements	2,0 d	18.01.2011	19.01.2011
10	Evaluate Business Approach	4,0 d	20.01.2011	25.01.2011
11	Define new entity requirements	1,0 d	20.01.2011	20.01.2011
12	Identify on-going business purchase opportunities	1,0 d	21.01.2011	21.01.2011
13	Research franchise possibilities	1,0 d	24.01.2011	24.01.2011
14	Summarize business approach	1,0 d	25.01.2011	25.01.2011
15	Evaluate Potential Risks and Rewards	7,0 d	21.01.2011	31.01.2011
16	Assess market size and stability	2,0 d	21.01.2011	24.01.2011
17	Estimate the competition	1,0 d	25.01.2011	25.01.2011
18	Assess needed resource availability	2,0 d	26.01.2011	27.01.2011
19	Evaluate realistic initial market share	1,0 d	28.01.2011	28.01.2011
20	Determine financial requirements	2,0 d	26.01.2011	27.01.2011
21	Review personal suitability	1,0 d	28.01.2011	28.01.2011
22	Evaluate initial profitability	1,0 d	31.01.2011	31.01.2011
23	Review and modify the strategic plan	2,0 d	01.02.2011	02.02.2011
24	Confirm decision to proceed		03.02.2011	

Timeline header: w2, 02 Jan 2011 | w3, 09 Jan 2011 | w4, 16 Jan 2011 | w5, 23 Jan 2011 | w6, 30 Jan 2011

Resource labels: Manager; Business Advisor, Manager; Manager; Business Advisor; Owners; Business Advisor, Peers; Accountant; Manager; Manager; Manager; Manager; Business Advisor; Business Advisor; Business Advisor; Business Advisor; Business Advisor; Manager; Manager; 03.02.2011

Many Project Mg't Products!

Microsoft Project

One from Georgia Tech

CASCADE-e http://www.cascad-e.net/Index.php

End of Visualizing Time Intervals

- Examples we have seen
  1. Prostrate cancer progression
  2. TimeSpan
  3. Meeting discussions
  4. Music over time
  5. Story Lines
  6. PERT Charts
- Explain each to a partner
  - What is not clear?
  - What are commonalities? Differences?
  - How are intervals visualized in each?
  - How do time intervals relate to one another in each?
  - How deal with scalability in each?
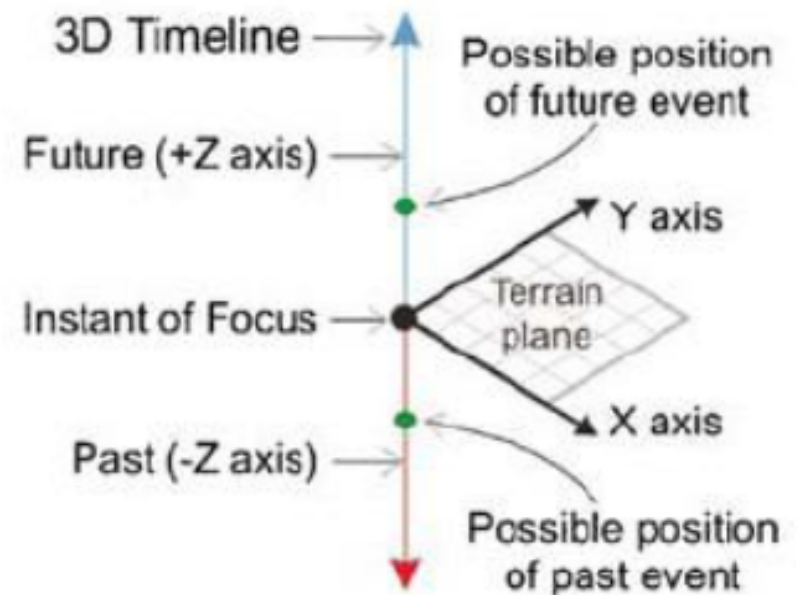
Example: Time + Geography

- 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 Uncharted (previously Oculus) https://www-prev.uncharted.software/

GeoTime Spatial Timelines
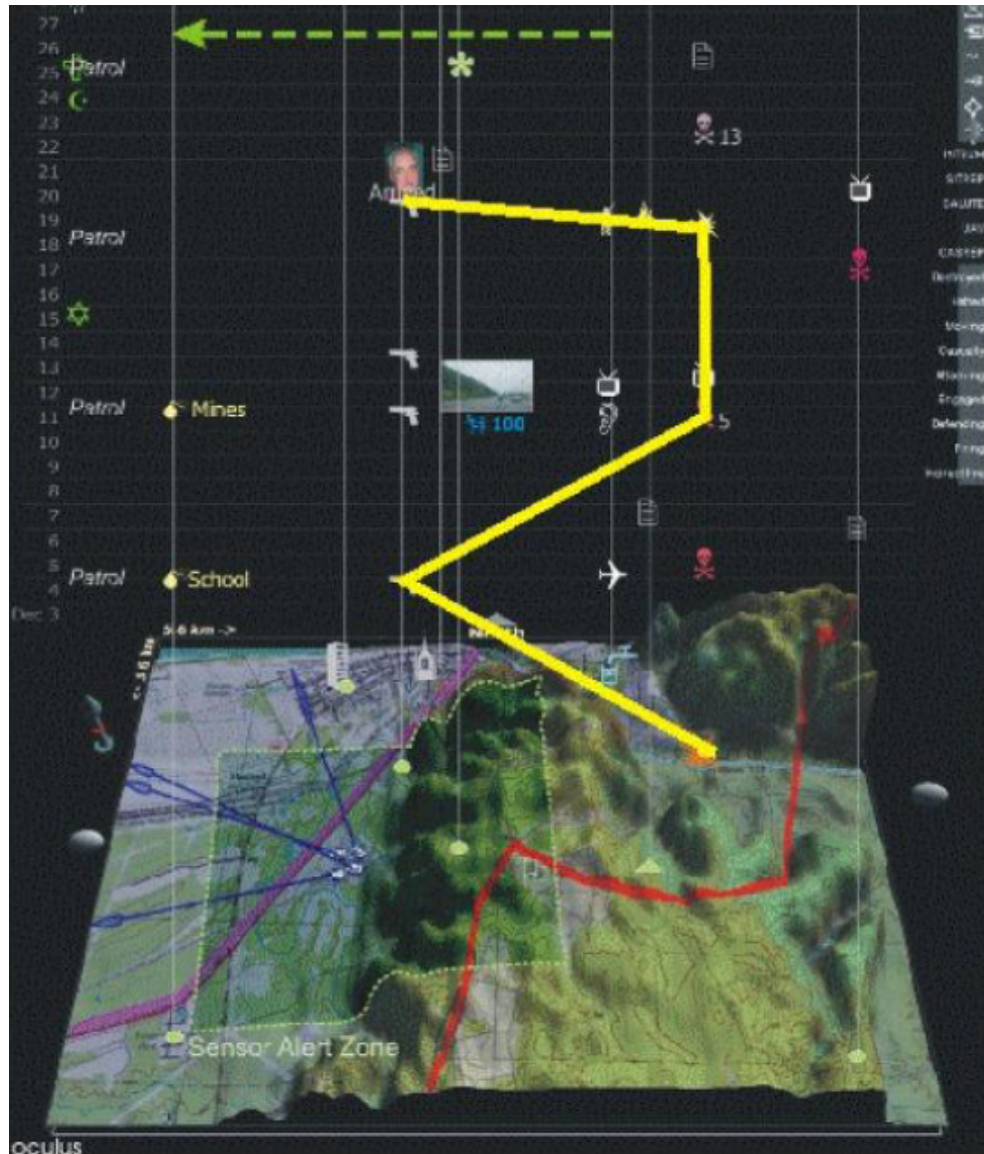
- Vertical time axis (z-axis)
- Terrain plane (xy
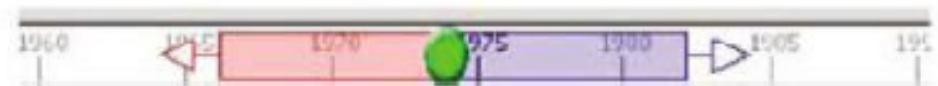
GeoTime Example

- From https://www.youtube.com/watch?v=CEsF8ARh8Jo

- My file

Time and Geography Story

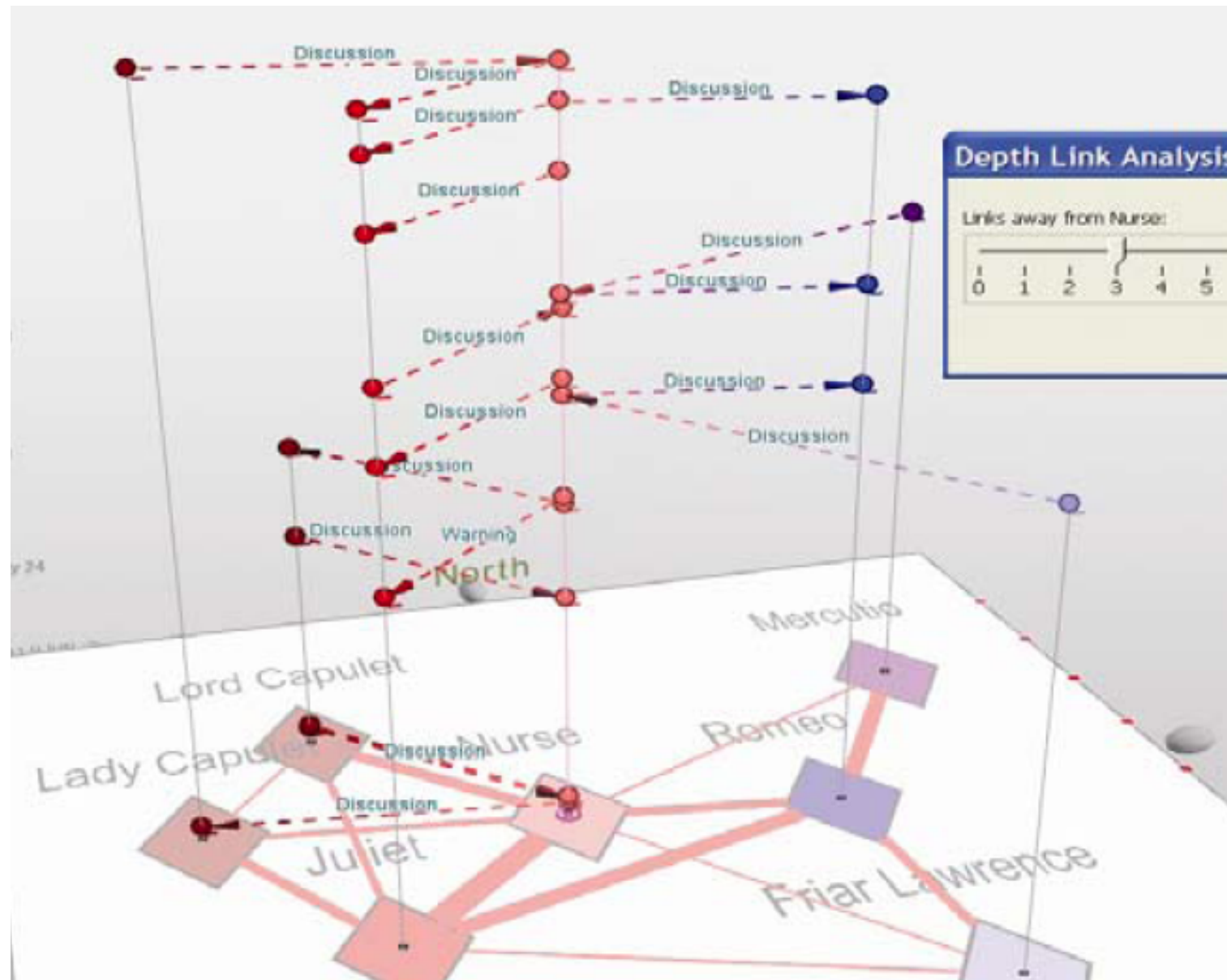Or an intelligence analysis ….   GeoTime
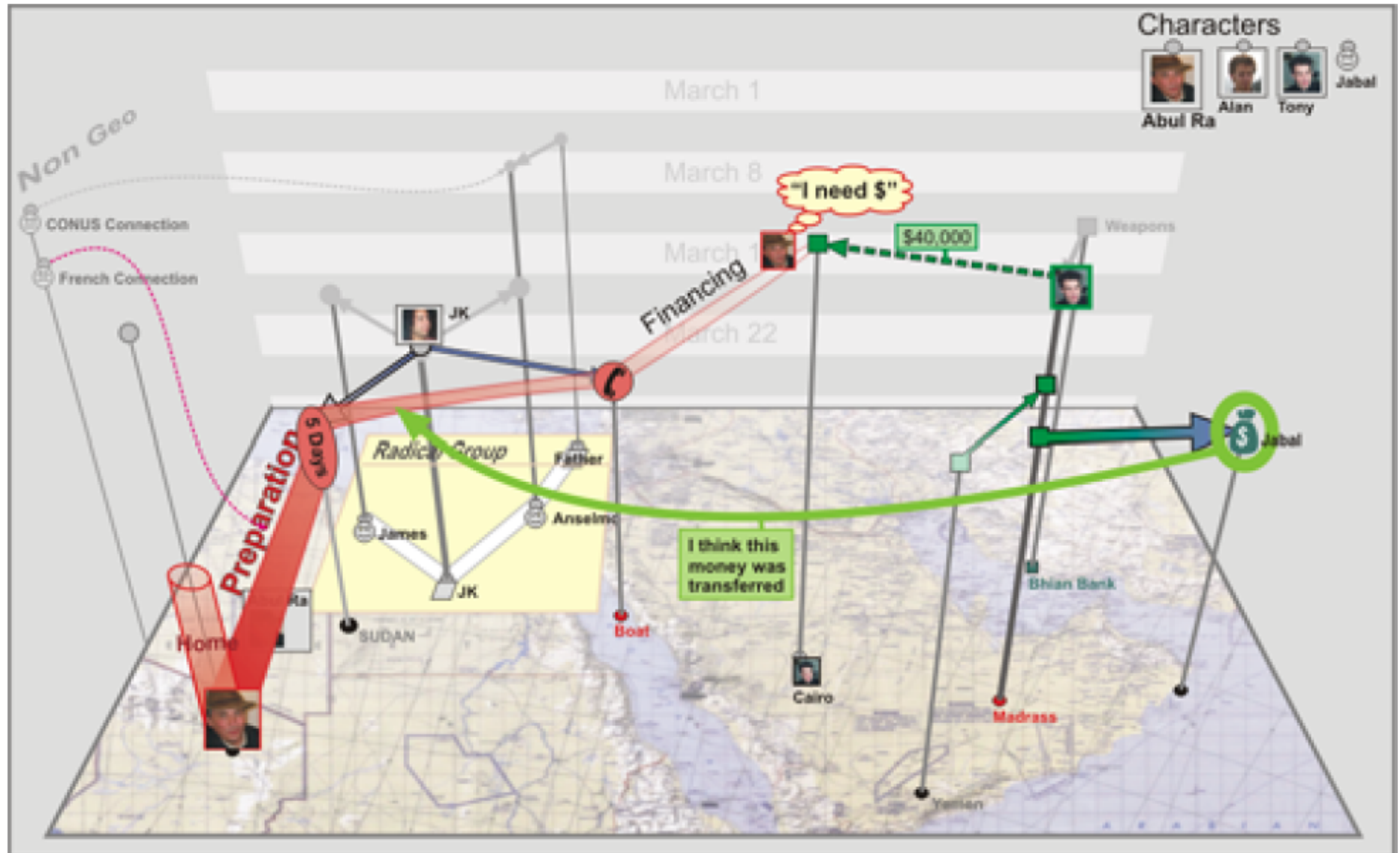
Literary Dialogue

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 VAST '08
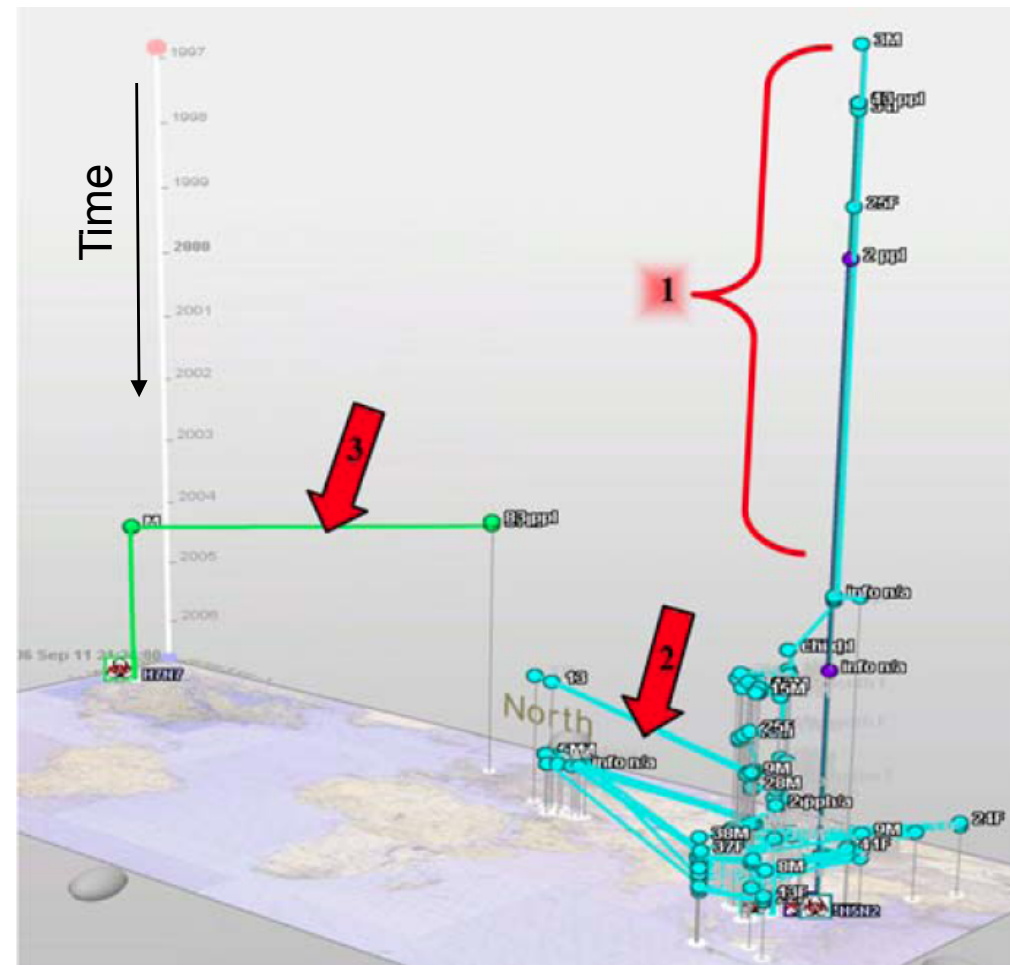
Time Series Tasks – More??

- 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

- 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