

# Synthesizing Interactive Visual Query Interfaces for Spatiotemporal Data Exploration and Analysis

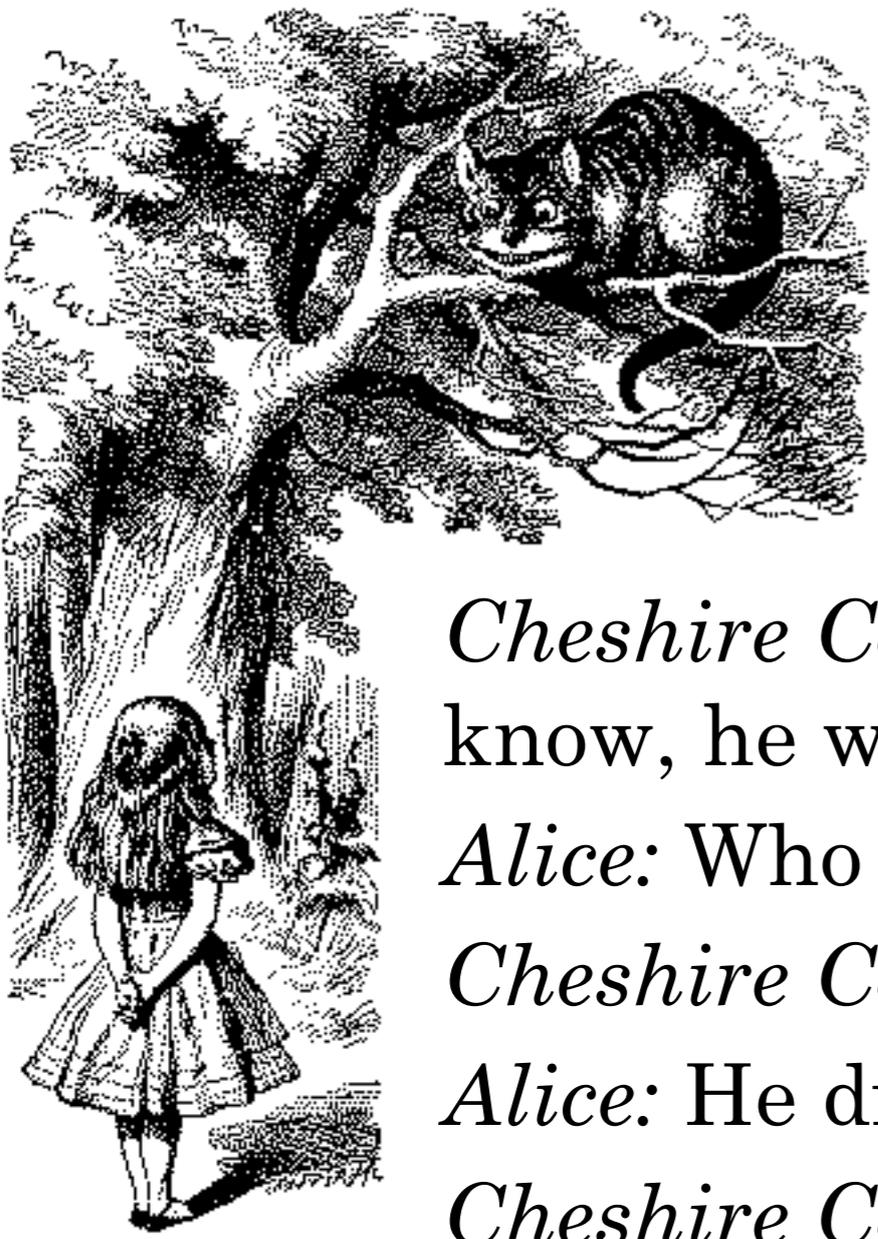
Chris Weaver

School of Computer Science and the Center for Spatial Analysis

University of Oklahoma

[weaver@cs.ou.edu](mailto:weaver@cs.ou.edu)

# Analysis in Wonderland



*Cheshire Cat:* Oh, by the way, if you'd really like to know, he went that way.

*Alice:* Who did?

*Cheshire Cat:* The White Rabbit.

*Alice:* He did?

*Cheshire Cat:* He did what?

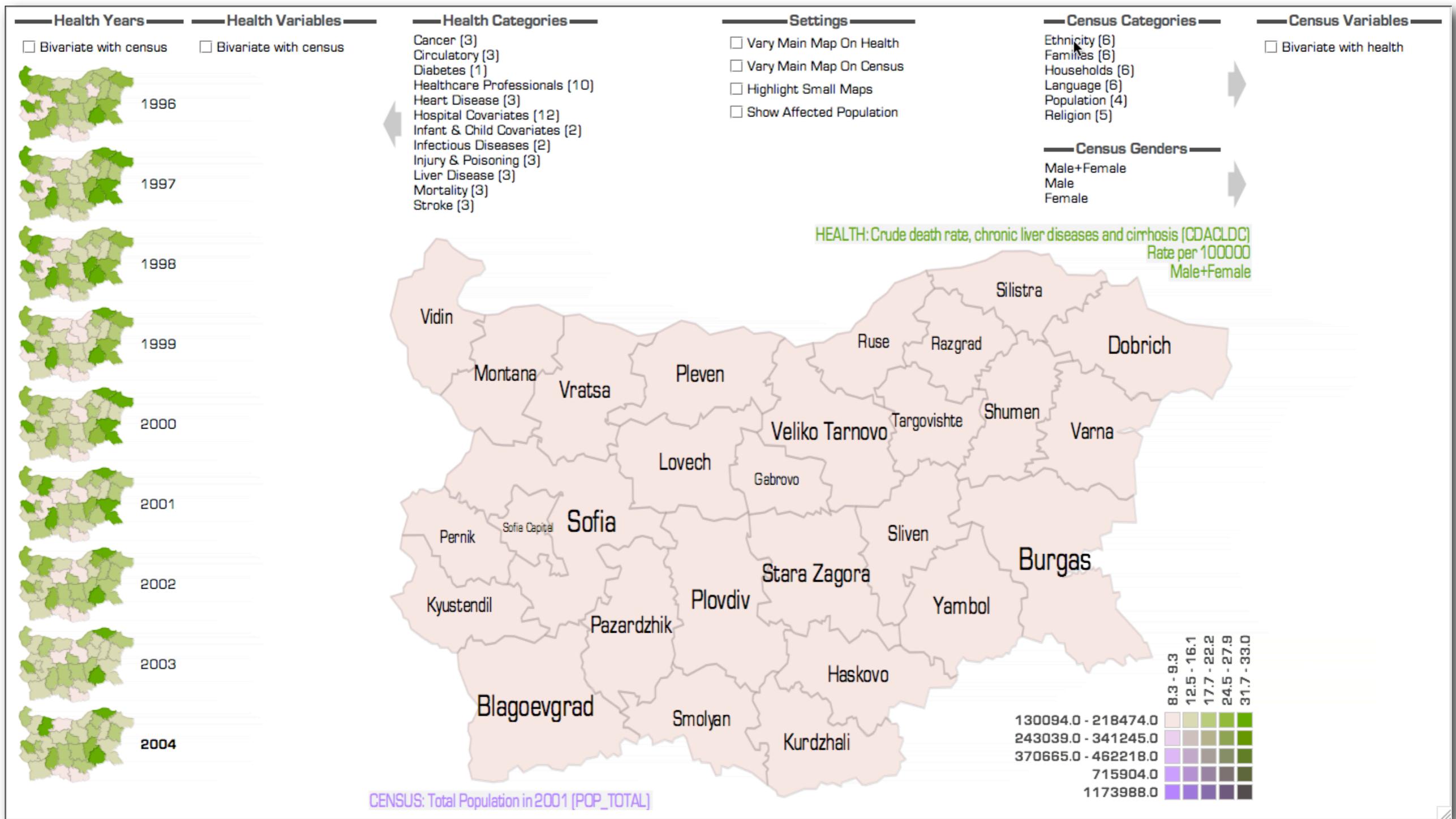
*Alice:* Went that way.

*Cheshire Cat:* Who did?

*Alice:* The White Rabbit.

*Cheshire Cat:* What rabbit?

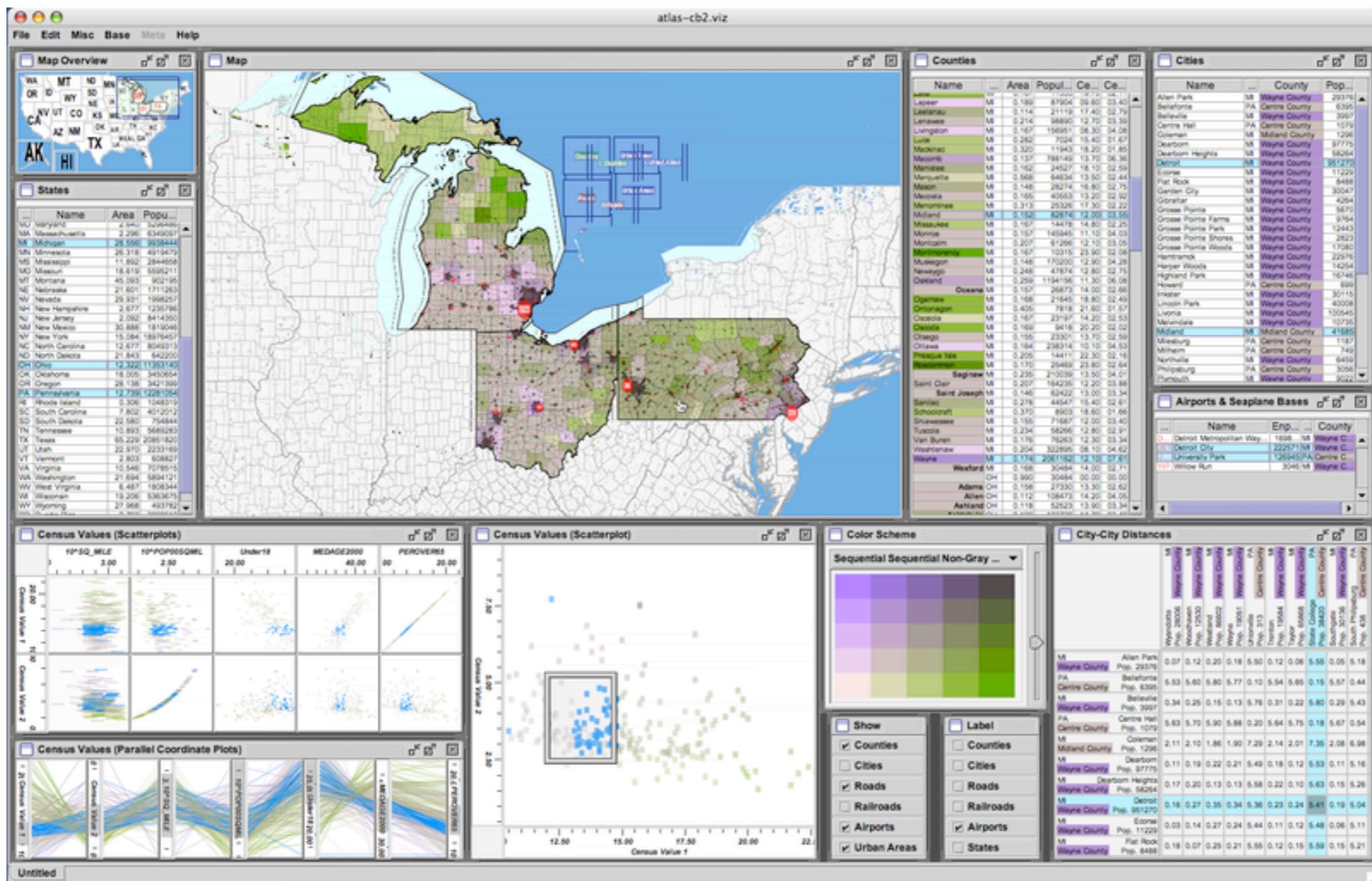
*Alice:* But didn't you just say - I mean - Oh, dear.



# bulgaria

oblast-level health demographics from 1996 to 2004

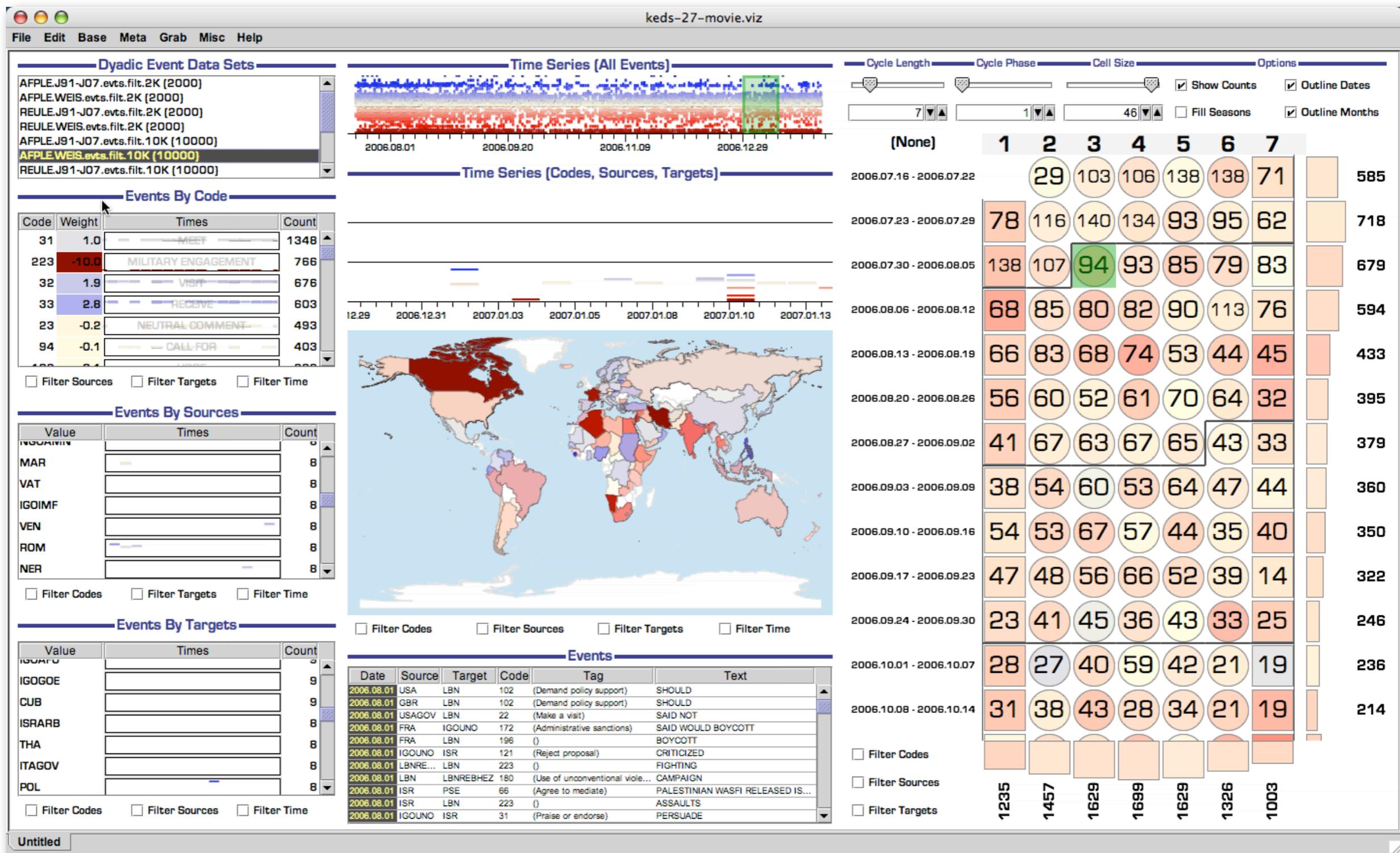
Collaborator and Data Source: Anthony Robinson, Penn State Geography



## census

2000 U.S. Census county-level demographics using cartographic techniques such as geographic projection, generalization, bivariate color schemes, and categorization (equal intervals, quantiles, Jenks natural breaks)

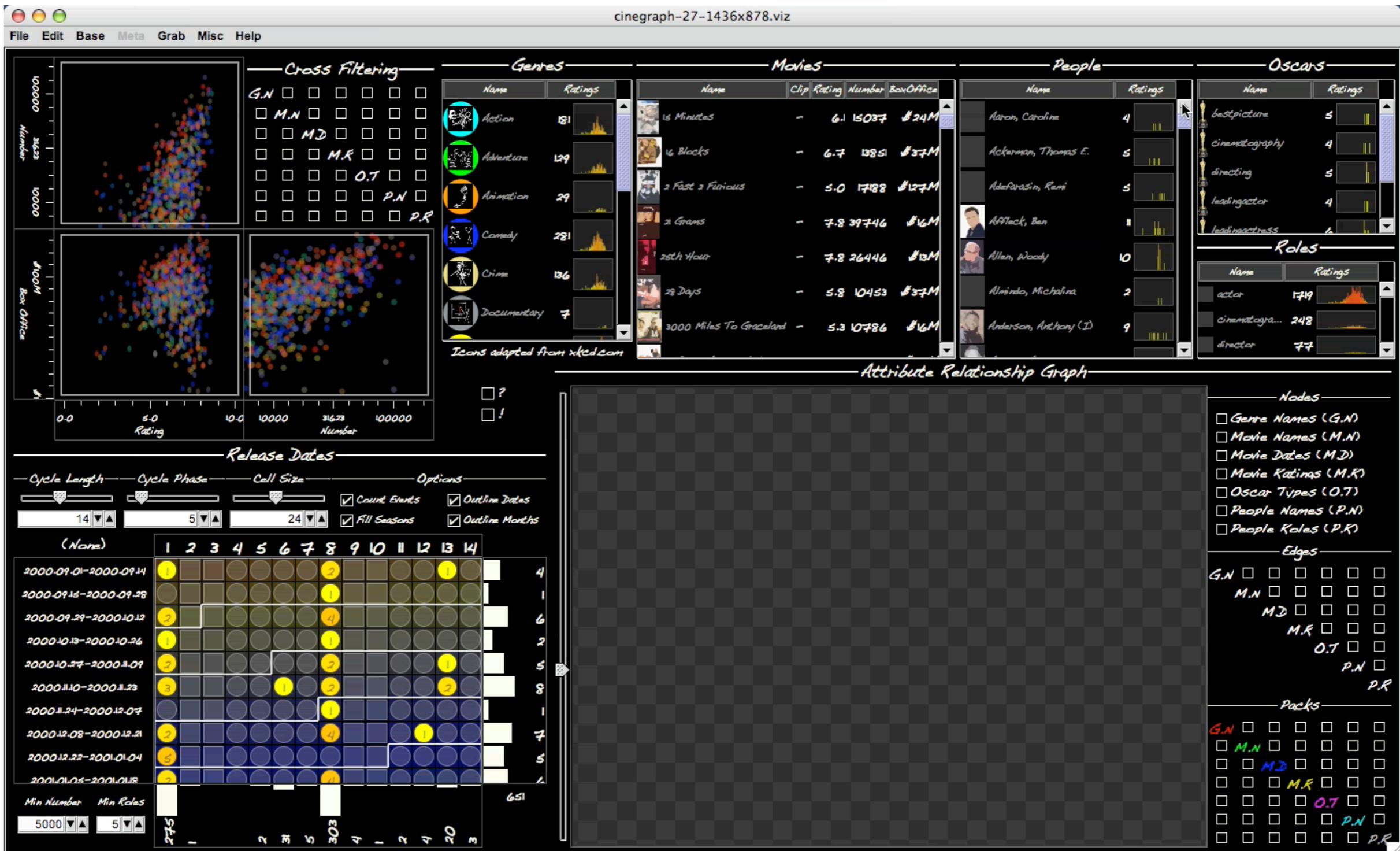
Data Source: The National Atlas (<http://www.nationalatlas.gov/atlasftp.html>)



# KEDS (Kansas Event Data System)

newswire-extracted international events between state-level actors

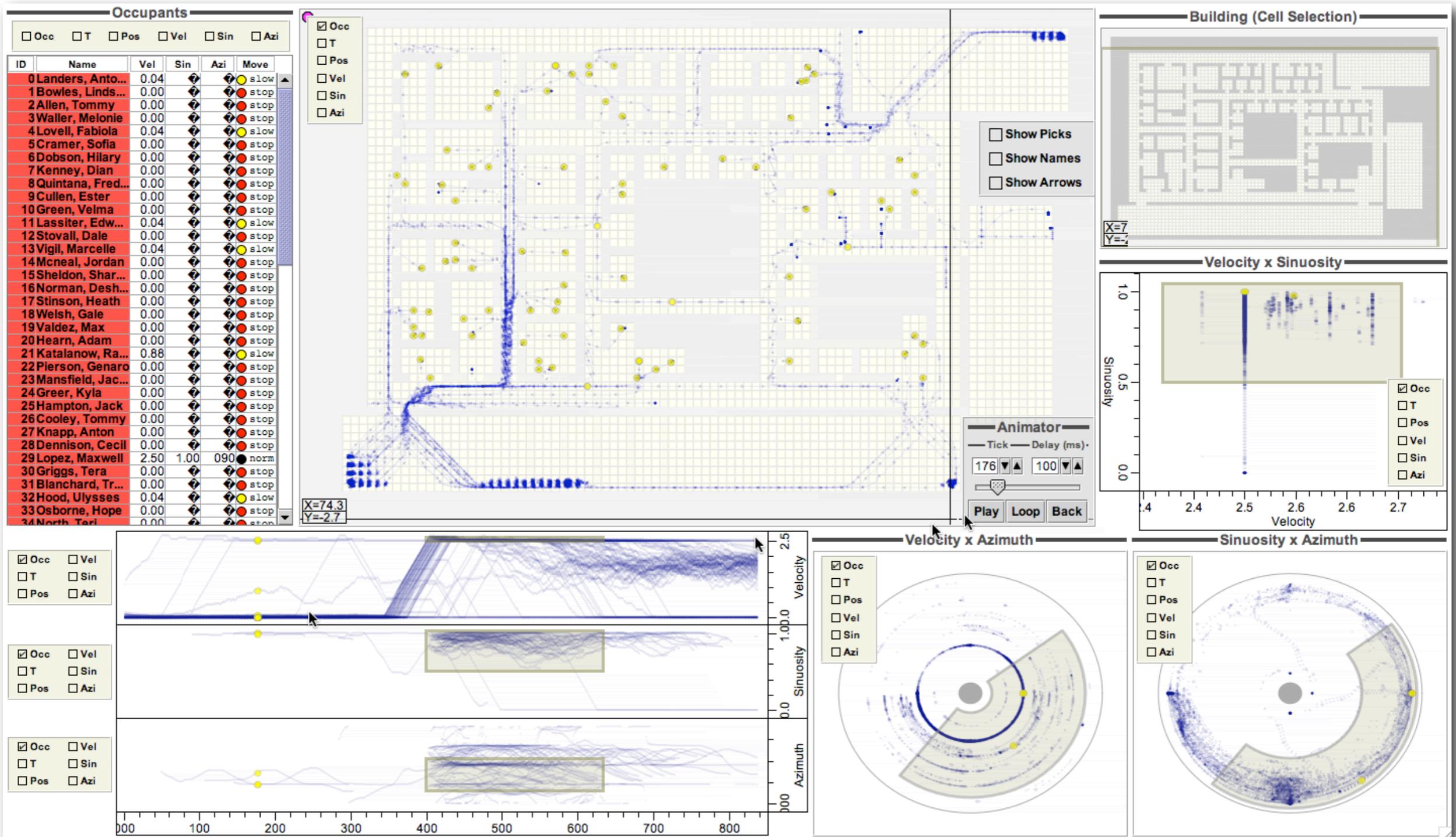
Collaborator and Data Source: Phil Schrod, University of Kansas Department of Political Science



# Cinegraph

High-dimensional drill-down into people, genres, awards, release dates, and box office characteristics of mainstream movies

Data Sources: [www.imdb.com](http://www.imdb.com) and InfoVis 2007 Contest Co-Chairs

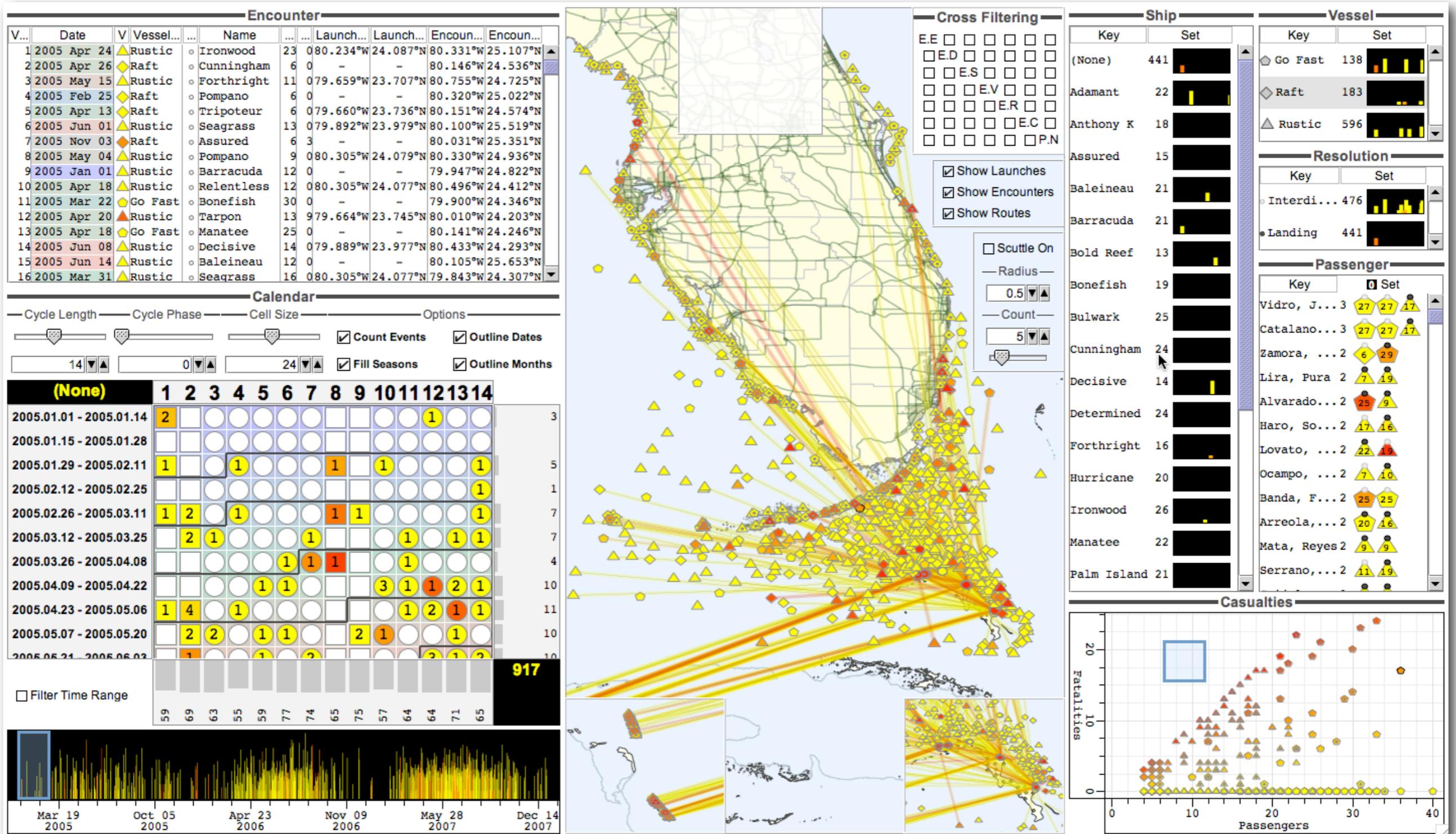


# evac

a visualization of movements of RDIF-carrying health care workers and visitors

Data Source: VAST 2008 Challenge, Evacuation Mini-Challenge (synthetic)

Visualization Design: Chris Weaver and Anthony Robinson



# boat

a visualization of boat landings and interdictions

Data Source: VAST 2008 Challenge, Boats Mini-Challenge (synthetic)

Visualization Design: Chris Weaver, Michael Stryker, Ian Turton

“What is the use of repeating all that stuff,” the Mock Turtle interrupted, “if you don’t explain it as you go on? It’s by far the most confusing thing I ever heard!”

“Yes, I think you’d better leave off,” said the Gryphon: and Alice was only too glad to do so.



# Improvise



- “Improvisational Visualization”
- An interactive visual query interface builder and browser
- Live design of visual tools for data exploration and analysis
  - Access and query data
  - Visually encode data
  - Create, coordinate, lay out views
  - ***Couple view interactions with data transformations***
- **Impact: quicker development of better visual analysis tools**

And it's free!

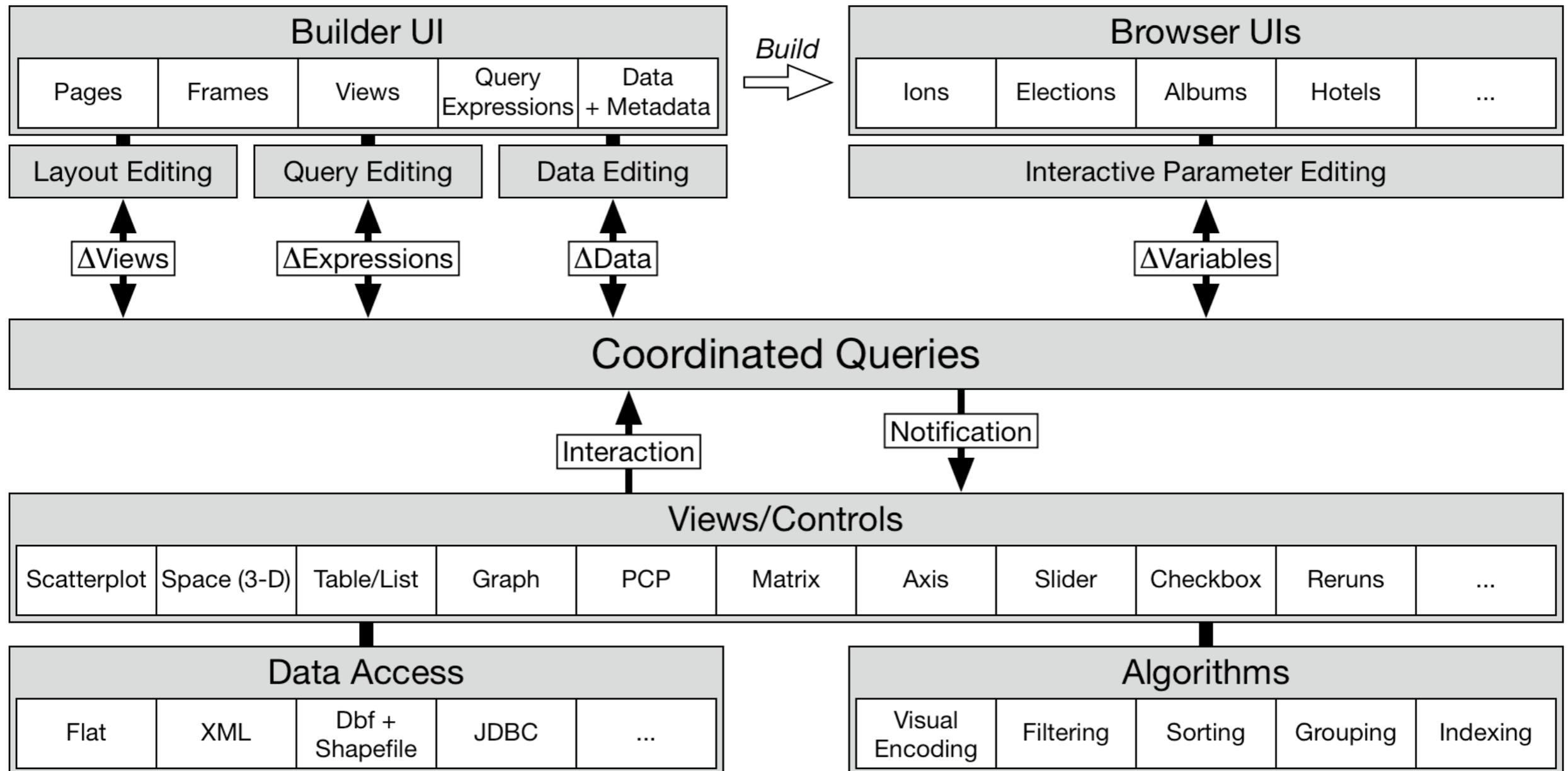
distributed under an open source license (GPL v2)

as a Java Web Start (JNLP) application

with many of the example visualizations

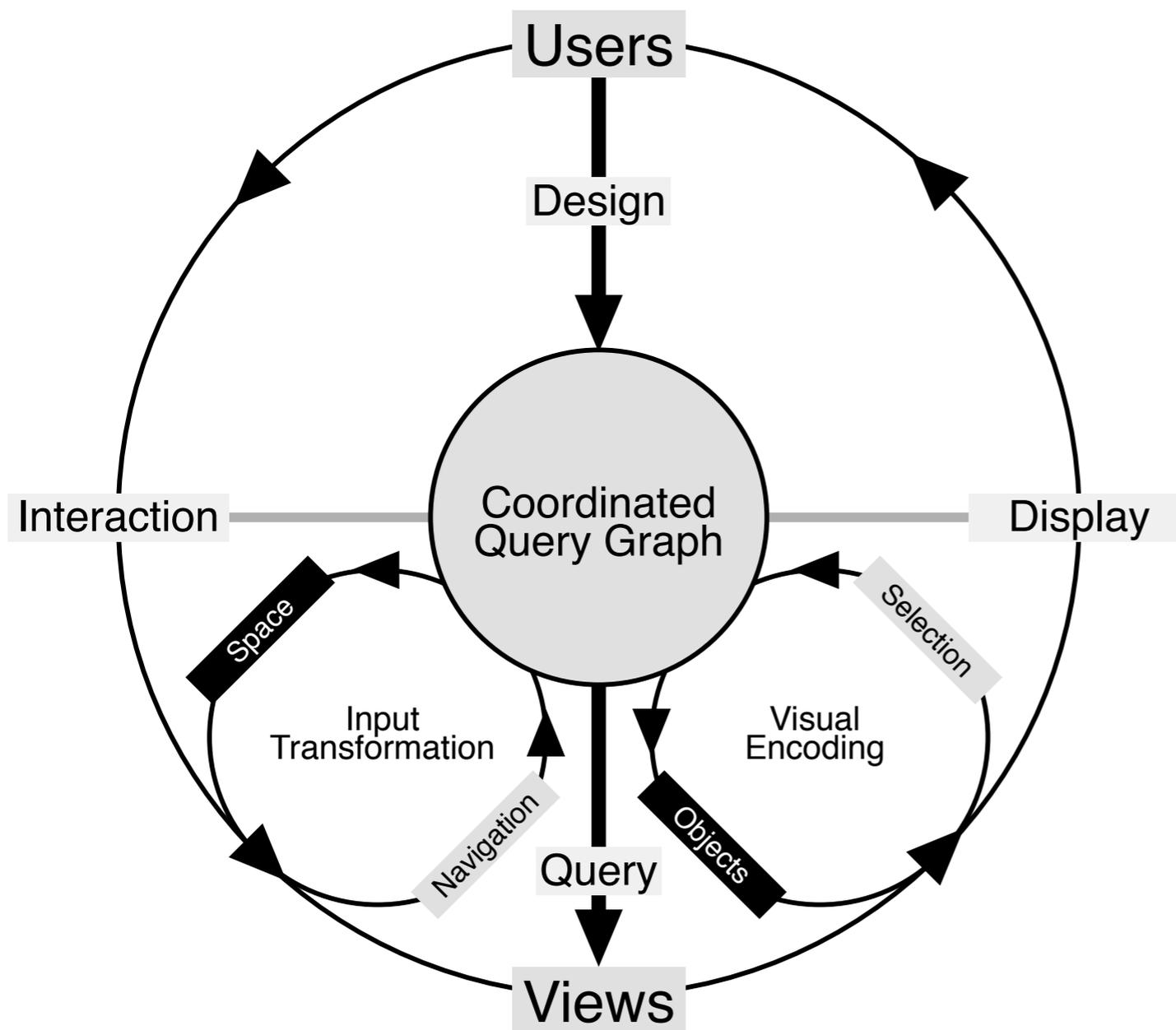
at <http://www.cs.ou.edu/~weaver/improvise/>

# Building and Browsing

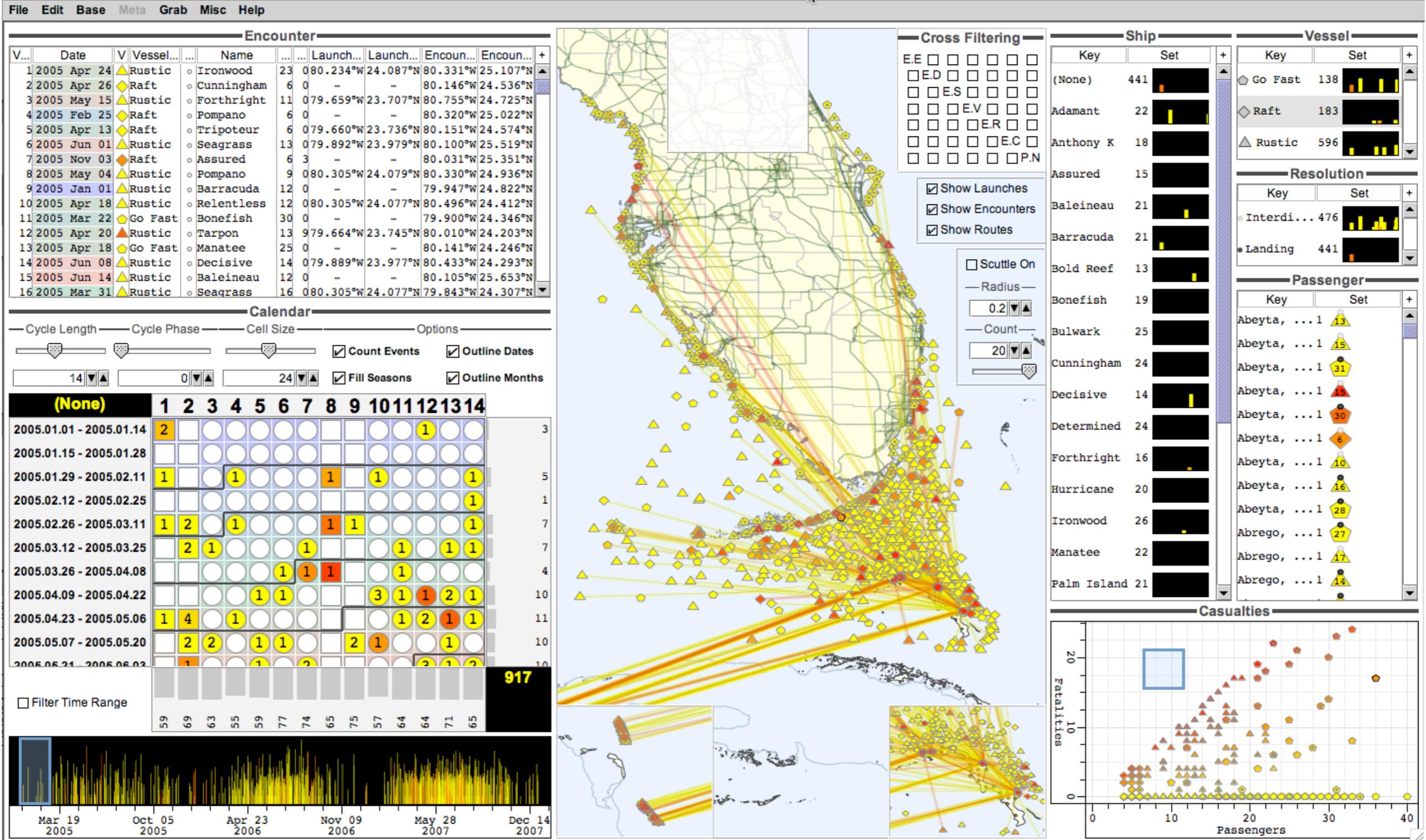


# Visualization in Improvise

Idea: Visualization as declaration of how interactive states determine visual forms and how visual forms constrain changes to interactive states



- A coherent, shared, high-dimensional state space of interactive parameters
- A graph of data record transformation statements with parameter references
- A set of views that process queries, render results, and map local interactions into parameter value changes.



# Implementation

- Architecture and User Interface
  - Self-contained builder+browser interface based on the desktop metaphor
  - Persistence of complete/partial visualizations as XML documents
- Module Library
  - Extensibility in data sources, types, structures, queries, display techniques
  - ~1500 functions on various data object types
  - Many adapted views and algorithms
  - Currently 30+ views and sliders
- Engineering
  - ~330,000 lines of Java + Swing + XML
  - Primary development from 1998-2004
- Typical Visualization
  - Hours to days to build
  - 10-25 view and sliders, 25-50 parameters, 25-100 query expressions

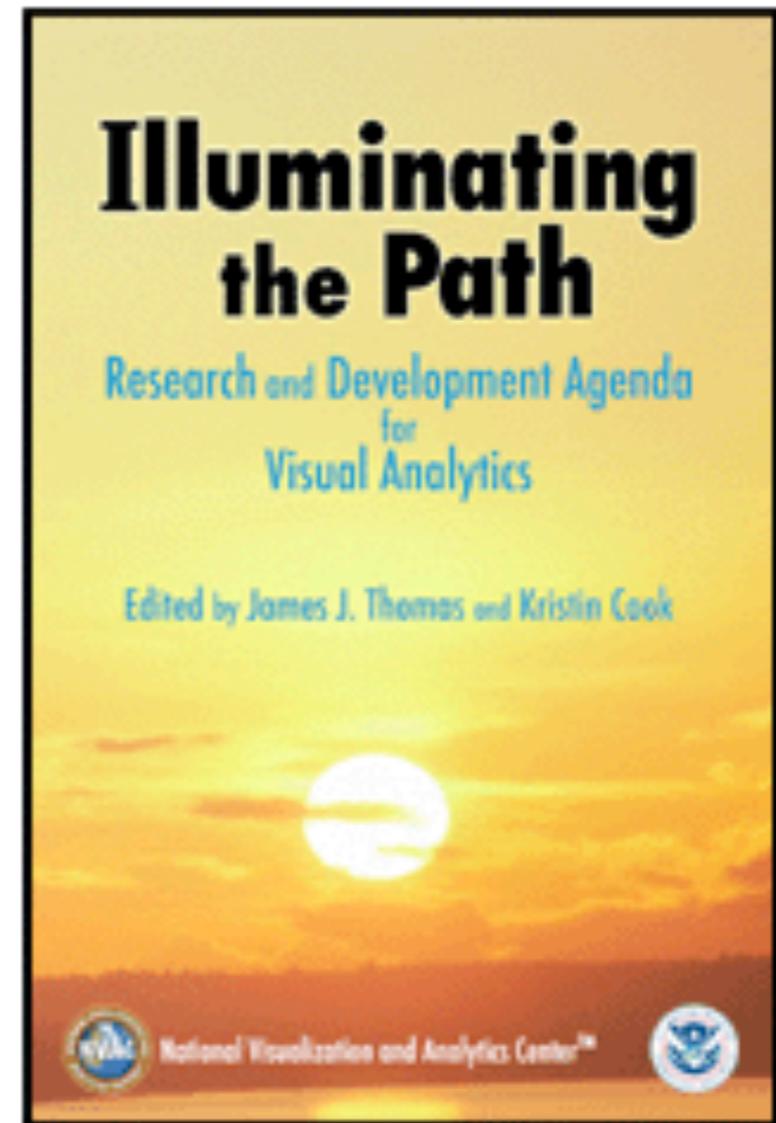


There was a large mushroom growing near her, about the same height as herself; and when she had looked under it, and on both sides of it, and behind it, it occurred to her that she might as well look and see what was on the top of it.



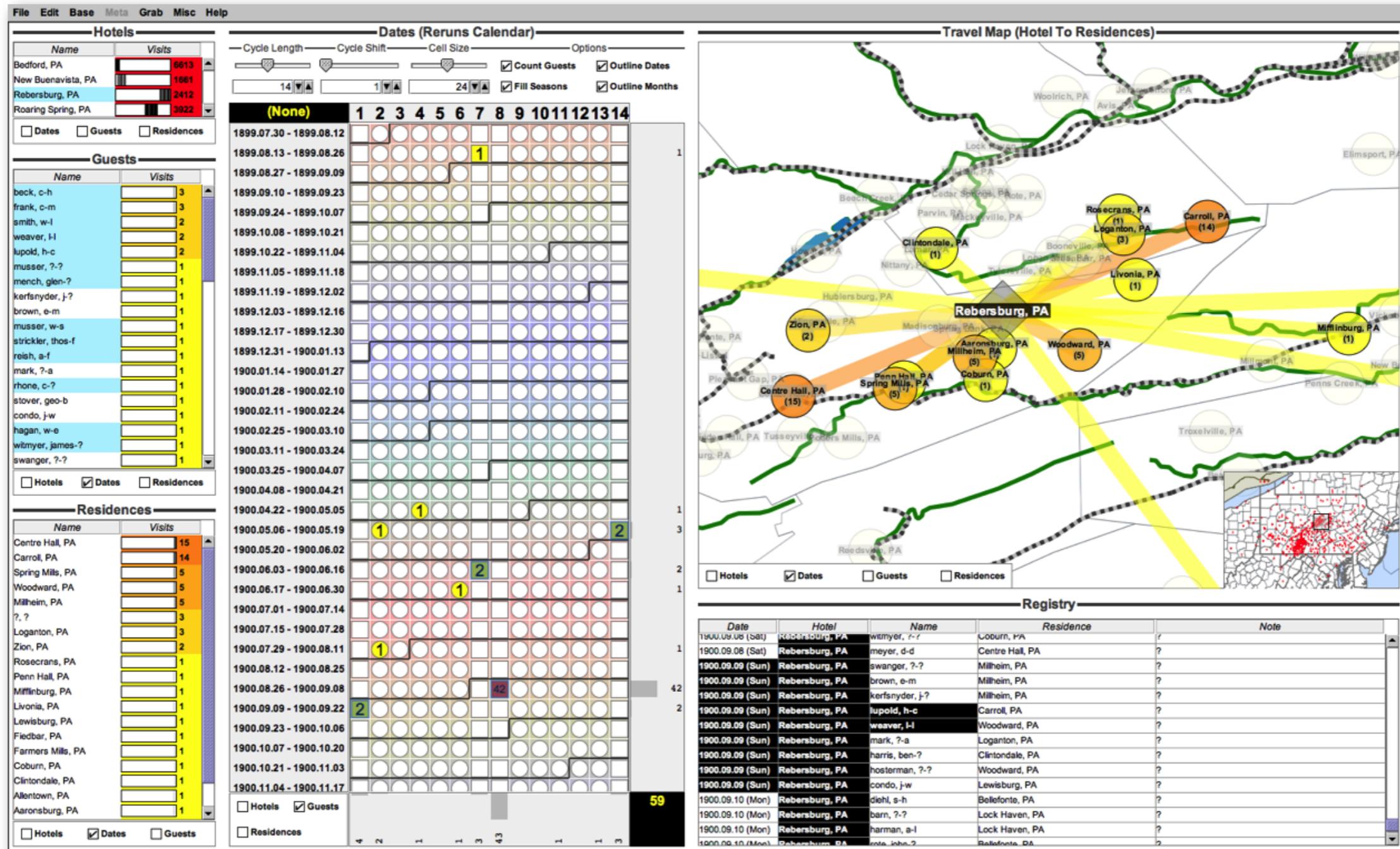
“Visual analytics is the science of analytical reasoning facilitated by interactive visual interfaces.”

- The process of analytic reasoning: perception, cognition, discourse, collaboration
- Data representation and transformation
- Visual representation and interaction
- Production, presentation, dissemination
- *Sense-making*: gather info, re-represent, develop insight, produce results



<http://nvac.pnl.gov/agenda.stm>

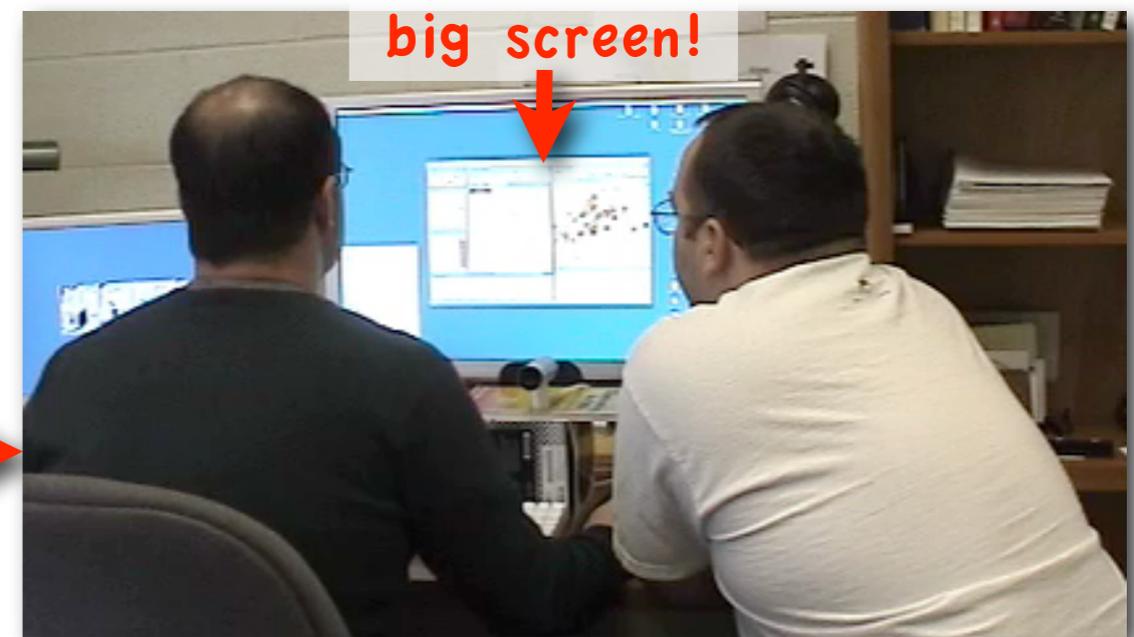
# Visual Analysis of Historic Hotel Visitation Patterns



Collaborators at Penn State:  
 David Fyfe & Deryck Holdsworth (*Historical Geography*)  
 Anthony Robinson, Donna Peuquet, Alan MacEachren (*GIS*)



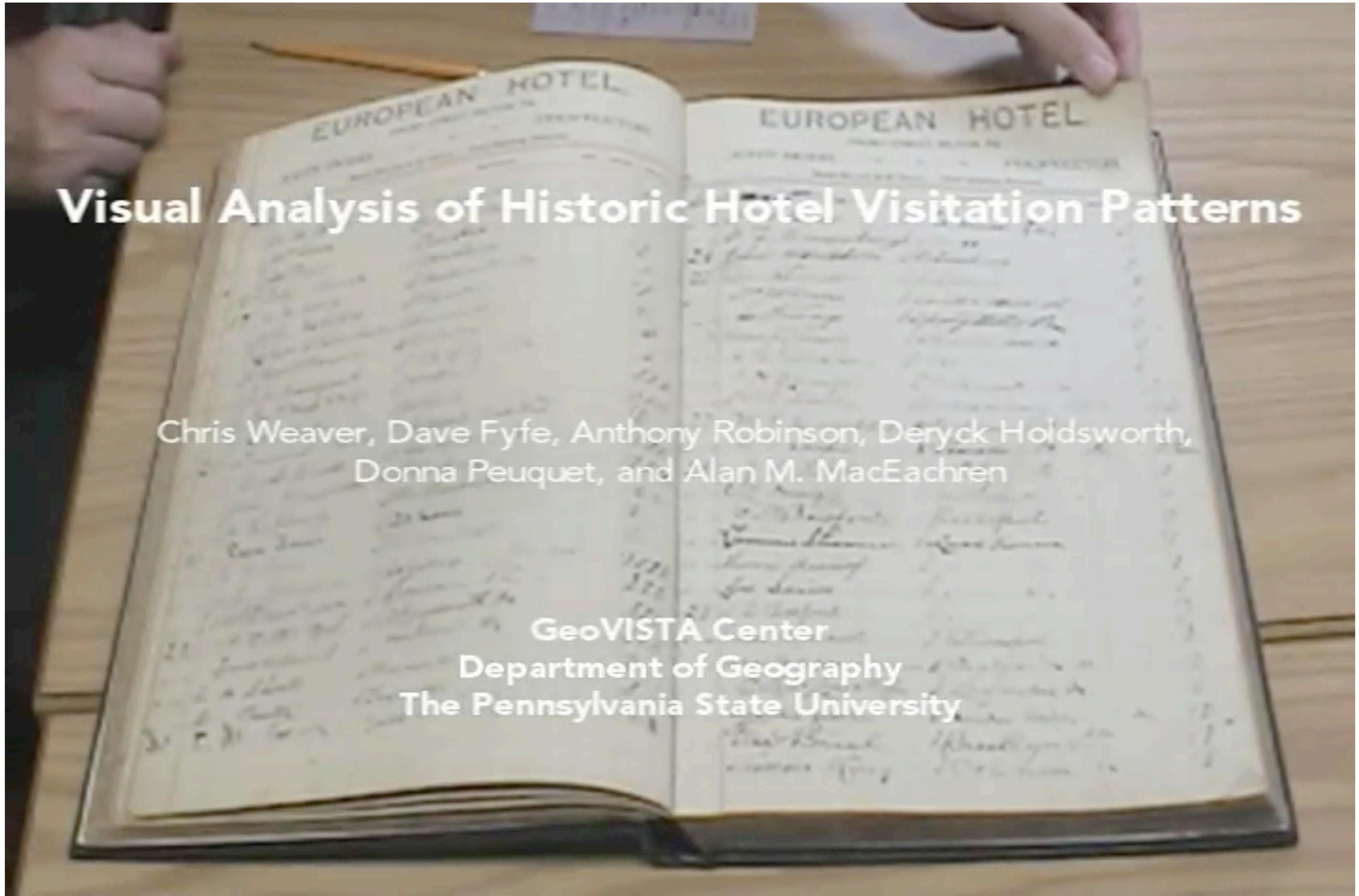
# Hotel Registries Visualization + Analysis



computer scientist →

↑  
historical  
geographer

- Process
  - Integrated visual software development
  - Rapid tool evolution using simple, common visual techniques
  - Immediate usability/usefulness feedback (not quite exploratory)
- Data
  - Space, time, and abstract attributes (people, places, and times)
  - Multiple sources of uncertainty
  - Of research interest to real users (historical geographers)
- Tasks
  - Explore behavioral patterns of individuals and groups
  - Correlate with multiple sources of external information: transportation schedules, weather records, newspaper reports, etc.
- Applicability
  - Analogy to current problems of interest in business and government
  - Uncontroversial data set?



# Visual Analysis of Historic Hotel Visitation Patterns

Chris Weaver, Dave Fyfe, Anthony Robinson, Deryck Holdsworth,  
Donna Peuquet, and Alan M. MacEachren

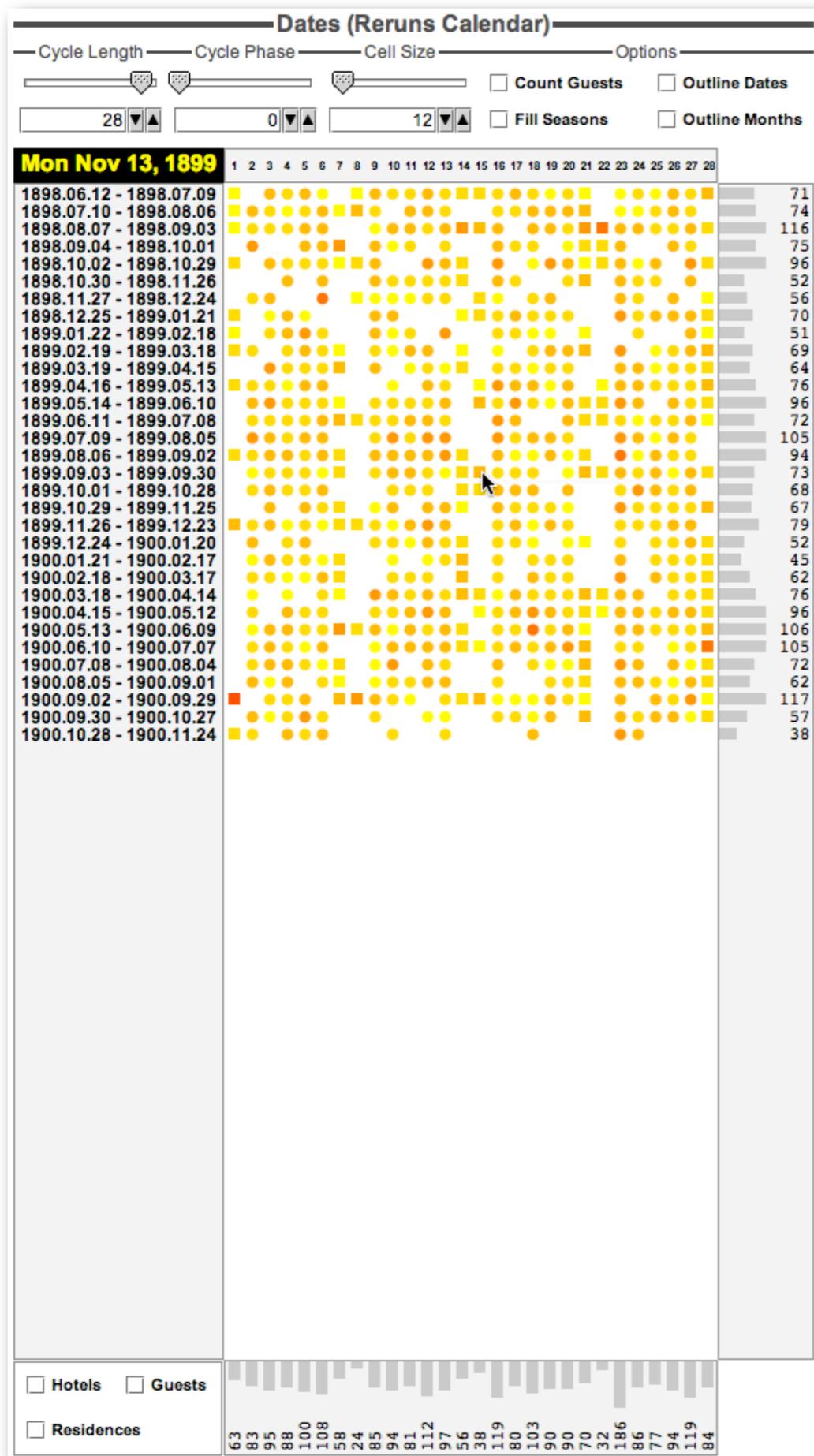
GeoVISTA Center  
Department of Geography  
The Pennsylvania State University



...when the Rabbit actually took a watch out of its waistcoat-pocket, and looked at it, and then hurried on,

Alice started to her feet, for it flashed across her mind that she had never before seen a rabbit with either a waistcoat-pocket, or a watch to take out of it,

and burning with curiosity, she ran across the field after it, and fortunately was just in time to see it pop down a large rabbit-hole under the hedge.



# Cyclic Time in Reruns

- Display time information in the cells of a wrapping spreadsheet
- Aggregate events in cells, rows, and columns
- Overlay multiple natural and artificial calendars using glyph-based visual encodings
- Dynamically adjust cycle length (and phase) to explore behaviors of varying duration
- Dynamically filter events on other attributes
- Exploits well-known, simple visual techniques: intuitive, fast, effective for analysis

# Temporal Patterns

Alternate time scales?

Spatial Patterns?

Space-time Patterns?

Periodicity	Visits	Guest/Home/Occupation	Hotel	Observations
Weekly Same Day	45	Harry Welshans Booneville Huckster	Rebersburg Hotel	Vertical pattern. Almost all visits on Tuesday.
Weekly Different Days	62	S. D. Fessler Hollidaysburg Unknown	National Hotel	Vertical pattern. Most visits Monday, Tuesday or Wednesday.
Biweekly Same Day	21	Harry McCloskey Coburn Unknown	Rebersburg Hotel	Vertical pattern. Almost all visits on Monday.
Biweekly Different Days	24	R. W. McEldowney Altoona Wholesale Salesman	National Hotel	Vertical pattern. Two weeks apart but no single day prominent.
Biweekly Mixed Days	36	John G. Felty Harrisburg Unknown	National Hotel	Vertical patterns. Several cases of two visits the same week (mostly Mondays, Thursdays).
Multiweekly Same Day	40	E. K. Hess Williamsport Traveling Salesman	Rebersburg Hotel	Vertical pattern. Most visits on Thursday. Always even number of weeks (up to 8) apart.
Multiweekly Different Days	27	Wm. R. Lytle Altoona Salesman	National Hotel	Vertical pattern. Almost always Monday-Wednesday, usually even number of weeks apart.
Bimonthly	48	R. L. Ehrenfeld Unknown (bar tender in 1900 census)	National Hotel	Diagonal Pattern. Visits during the middle and end/beginning of months.
Monthly Consecutive Days	30	Samuel McCurdy Hollidaysburg Unknown	National Hotel	Diagonal pattern. Consecutive days most months.
Monthly	44	Wm. Smeltzer Woodbury Unknown	National Hotel	Diagonal pattern. Most visits occurring from the 17th to the 22nd of each month.
Mixed	44	Thos. Weir Altoona Unknown	National Hotel	Begins with vertical pattern every other Monday. Switches to diagonal pattern during the middle of the month (15th).
Weekday/Weekend	Various	N/A	Both	Vertical patterns. Fewer on weekends than weekdays.
Seasonal	Various	N/A	Both	Vertical histograms undulate with seasons. More visits during the summer than winter.
Seasonal Variation	78	A. M. Sheats Booneville Huckster	Rebersburg Hotel	Deviations from vertical pattern during winter months.

“Let’s consider your age to begin with—how old are you?”  
asked the White Queen.

“I’m seven and a half exactly,”  
said Alice.

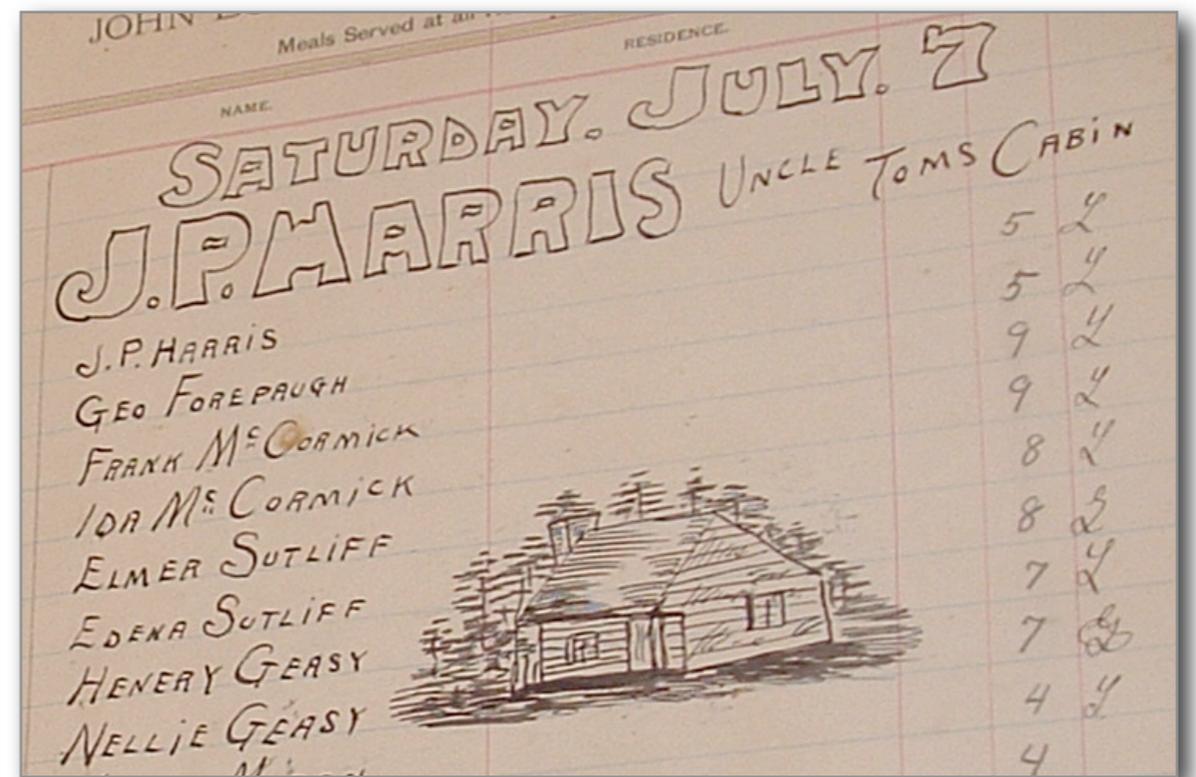
“You needn’t say ‘exactly,’” the  
Queen remarked: “I can believe  
it without that. Now I’ll give  
you something to believe. I’m  
just one hundred and one,  
five months and a day.”

“I can’t believe that!” said Alice.



# Uncertainty in Archival Documents

- Drawing and annotation (guest and/or proprietor)
- Incompleteness and variability (proprietor)
- Deception (guest and/or proprietor)
- Heat and water damage
- Fading
- Transcription
  - Paid undergrads (& Dave's mom!)
  - Flips and skips
- Speculative correction (researcher)
  - Guessing some date transitions
  - Merging similar names, residences
  - Mapping locations into modern place names



# Dealing with Uncertainty

Residences	
Name	Visits
lbg, PA	1
logantown, PA	2
lowe, ?	1
mpes?, ?	1
none given, ?	1
north ??, ?	1
not legible, ?	1
not legible, FL	1
not legible, NY	1
not legible, No Residenc...	3
not legible, PA	77
not legible, not legible	1
np, PA	859
ronola?, ?	1
union Co., ?	1

Hotels    Dates    Guests

- Some sources of uncertainty are important and interesting in and of themselves, e. g. deception.
- Preserve uncertainty in the data representation!
- Indicate uncertainty qualitatively rather than with quantitative measures, e.g. '?' in text.

- Hypotheses are conceptual associations of items.
- Express hypotheses by collecting similar items into groups interactively.
- **Depend on expert knowledge to define similarity within an analytic context.**

Guests	
Name	Visits
menm, trnos-1	1
hering, h-b	2
herman, lizzie-?	1
hess, ?-?	2
hess, ?-k	3
hess, c-b	1
hess, d-k	5
hess, e-k	27
hess, e-m	1
hess, ed-keagy	1
hess, i-p	1
hess, o-?	1
hettinger, e-c	1
heuch, nicholas-paul	1
heyburn, c-f	1
hielmer, deziel?	1

Hotels    Dates    Residences

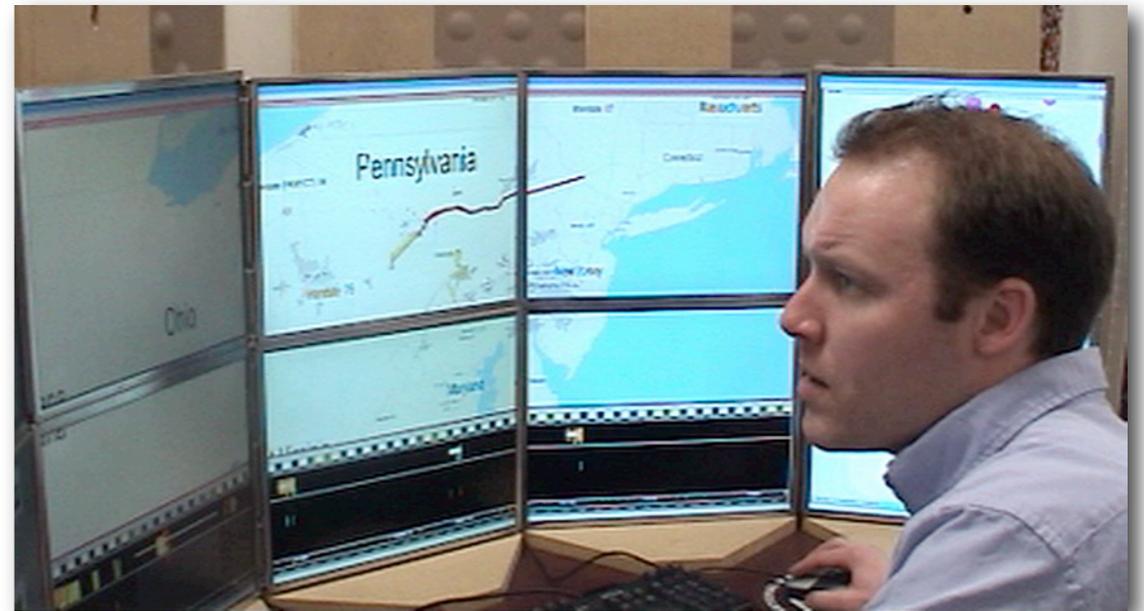
# What Have We Learned?

- Benefits for them (the domain experts)
  - Much faster exploration and analysis than with static spreadsheets
  - Discovery of over 20 hypothetical patterns (mostly temporal) so far
  - Ability to identify errors and systematic problems in the transcription process
  - Confidence to expand data collection despite expense and effort
- Benefits for us (the visualization researchers)
  - Evolve & evaluate system/techniques “in the wild”
  - Access to compelling, relevant, suitable data sets
  - Avoid data use issues (privacy, classification, etc.)
  - **Real, motivated, accessible, expert users!**
- Observations
  - Frequent, iterative feedback benefits both parties
  - In practice, designers and experts can often work side-by-side
  - Can get good mileage with simple techniques and multiple views
  - Find data-rich, tool-poor sociologists to collaborate with!
  - **Great model for student projects in visualization & software engineering**



# Evaluation of the Hotels Visualization

- Twelve graduate students in our Geovisual Analytics seminar
  - adapted e-Delphi [Pike2005] to support group input to software evaluations: user-centric, distributed, asynchronous
  - provoked suggestions for scenarios, additional datasets, extensions
  - **more geography, more guest details (!), more capture/annotation tools**
- Two geospatial intelligence analysts
  - training, competency test, exit survey
  - elicitation of opinions on:
    - utility and usability of targeted features
    - learnability
    - readiness for insertion into the workplace
    - benefits over tools already in the workplace
  - **the model of analysis is fast and easy to train, but hard to sustain during use**



“I wish you wouldn’t keep appearing and vanishing so suddenly; you make one quite giddy!”

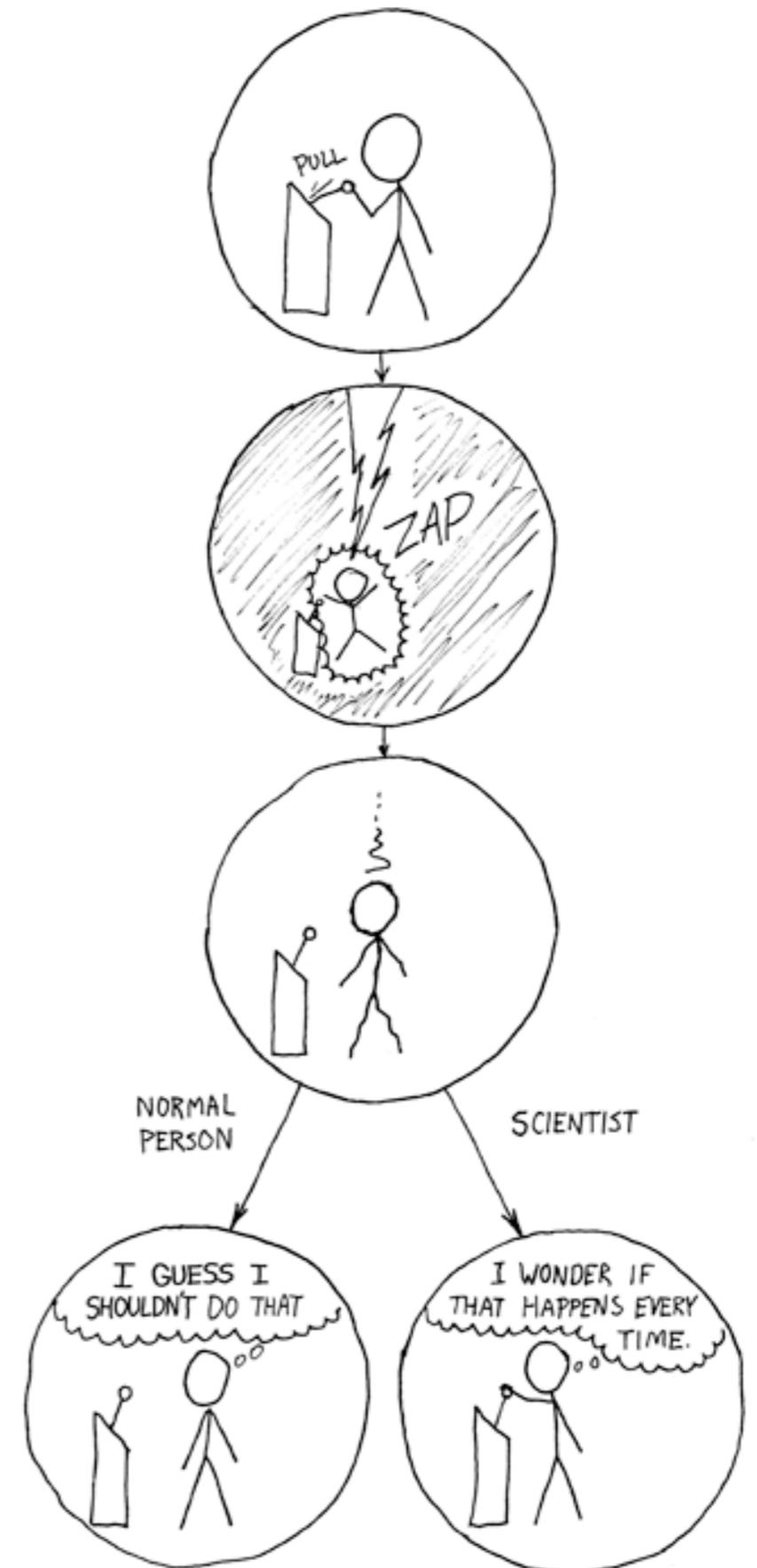


“All right,” said the Cat; and this time it vanished quite slowly, beginning with the end of the tail, and ending with the grin, which remained some time after the rest of it had gone.

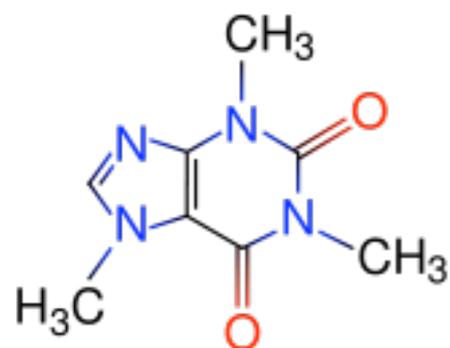
“Well! I’ve often seen a cat without a grin,” thought Alice; “but a grin without a cat! It’s the most curious thing I ever saw in all my life!”

# Visualization as...

- Information visualization tools increasingly employ compositional design based on coordinated and multiple view techniques.
- The amount and complexity of coordination in tools seems to be growing ... beneficially?
- But, the majority of tools incorporate and evaluate coordination in an ad hoc manner: ***visualization as craft.***
- **Visualization as science must encompass both analysis and synthesis.**



xkcd.com (Randall Munroe)

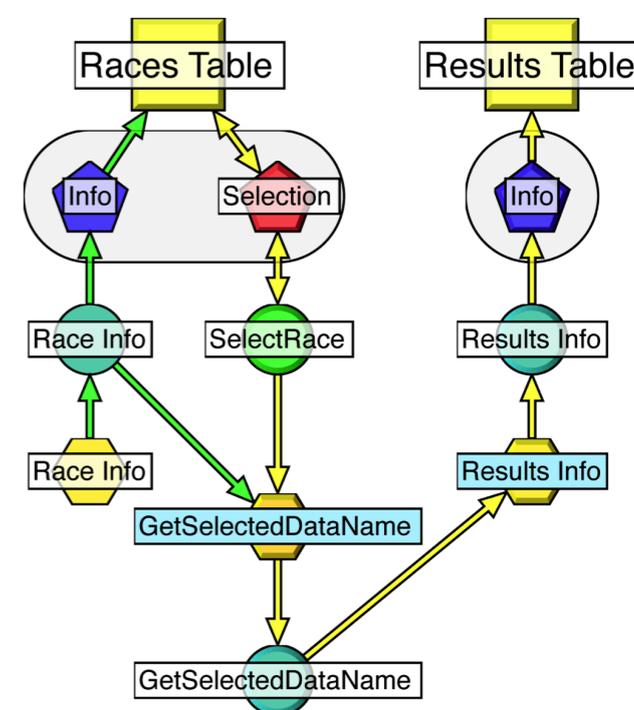


# Visual Analysis and Synthesis

- The recently established area of visual analytics is concerned with
  - visual models, techniques, and tools in support of analytic reasoning, and
  - broad social processes in visualization research, development & application.
- Look forward to a new area of visualactive synthesis concerned with
  - identifying compositional elements and levels of compositional abstraction,
  - developing patterns of composition and compositional pathways, and
  - matching compositions with analytic needs (info-seeking goals and tasks).

• Visualactive =  $\left\{ \begin{array}{l} \text{highly visual} \\ \text{highly interactive} \\ \text{data oriented} \end{array} \right.$

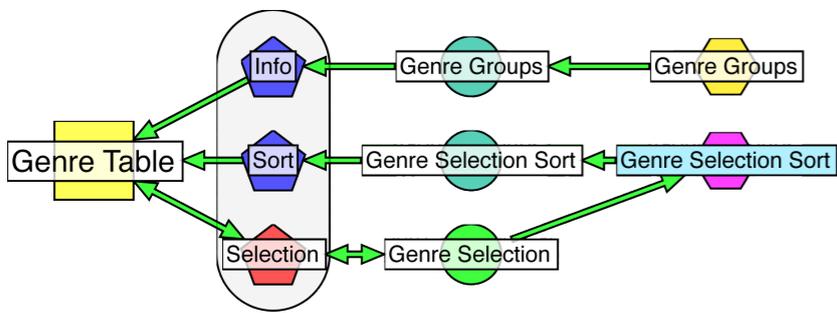
- Analogy: analytic and organic chemistry



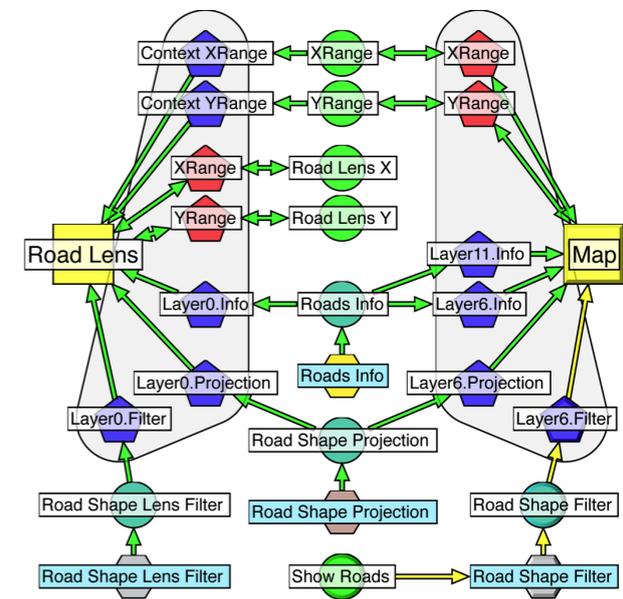
# Synthesizing Visualactive Compounds

- Conceptualize compositions of views, queries, and coordinations as instances of particular **coordination patterns**.
- Provide a working environment for discovering and studying coordination patterns.
- Incorporate patterns into visualization design tools.
- Apply and evaluate patterns in targeted visualization tools.
  - Identify and characterize variations of known patterns.
  - Establish the scope of effective customization.
  - Combine patterns into higher-order constructions.

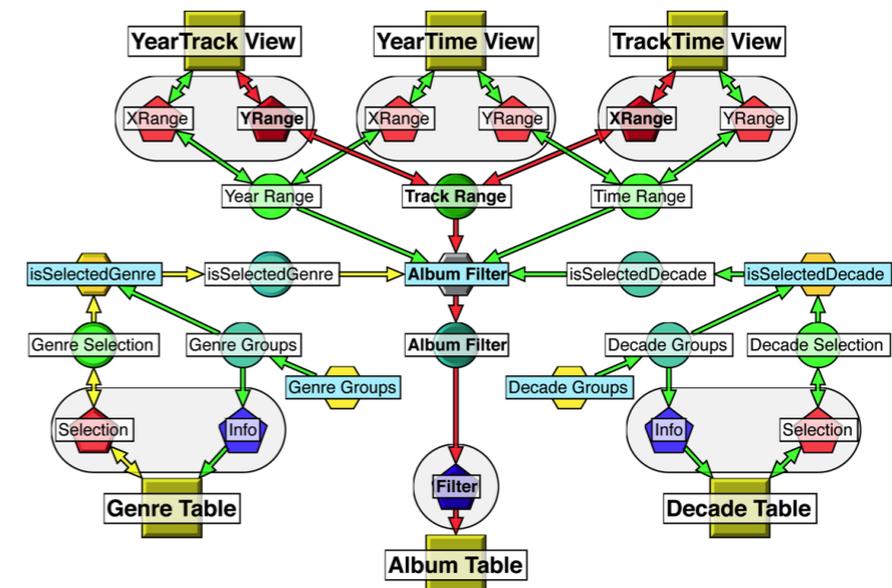




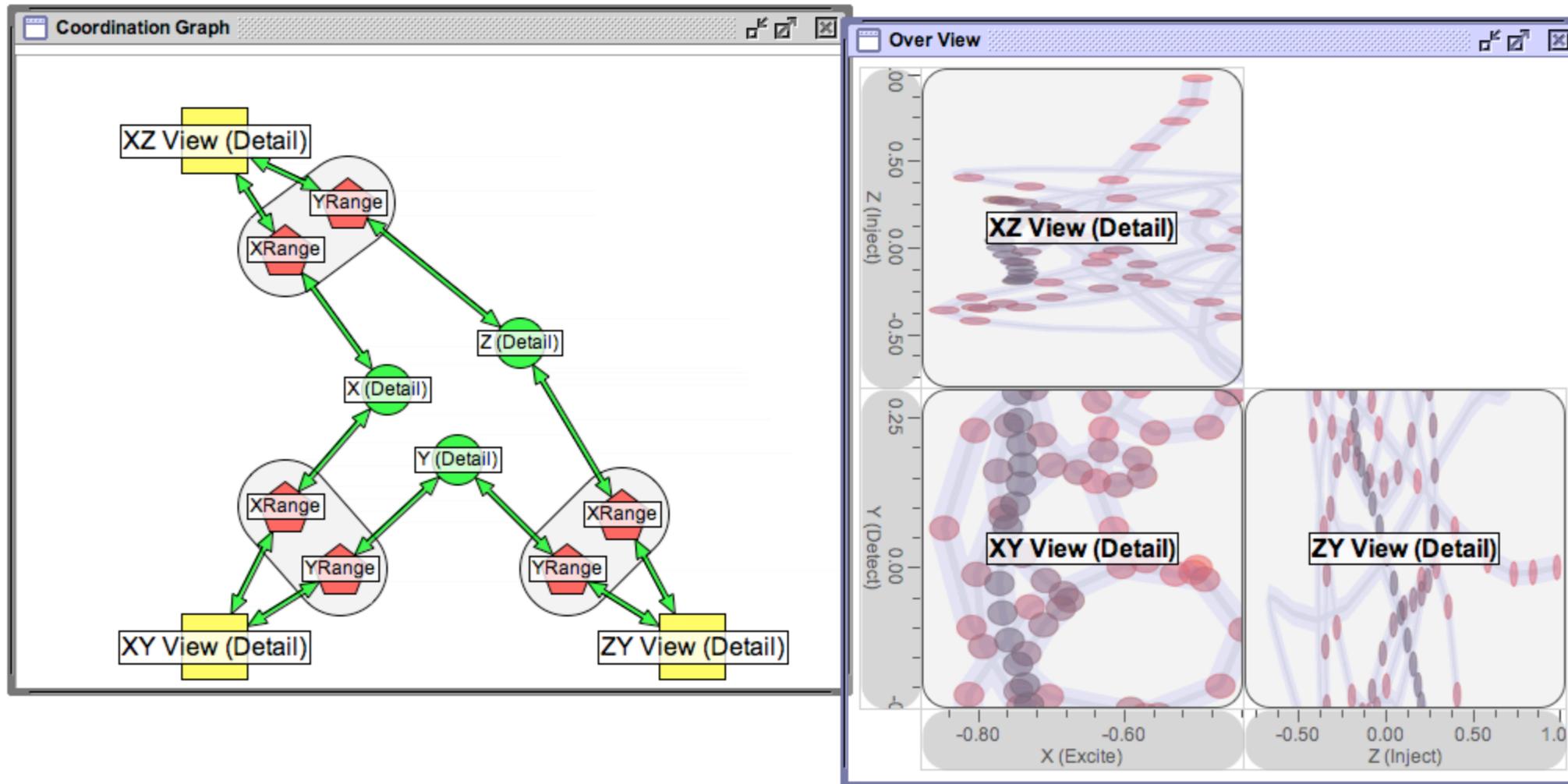
# Coordination Patterns



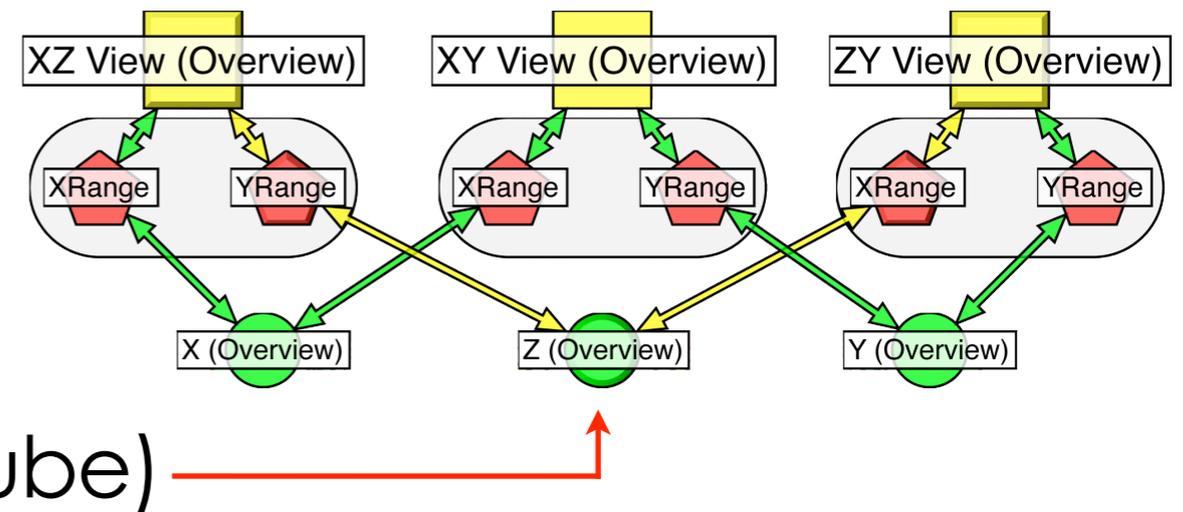
- Recipes for building visualizations using multiple views
- Inspired by software design patterns [Gamma1994]
- Narrower focus than infovis software design patterns [Heer2006]
- **Navigation** — Manipulate points, ranges, and other spatial regions.
- **Selection** — Distinguish arbitrary sets of data items.
- **Ordering** — Visually prioritize data items.
- **Containment** — Present additional information in existing views.
- **Mutation** — Radically alter visual encoding in response to navigation.
- **Compound** — Interconnect multiple views of multiple data sets through multiple coordinations to create complex interface behaviors.



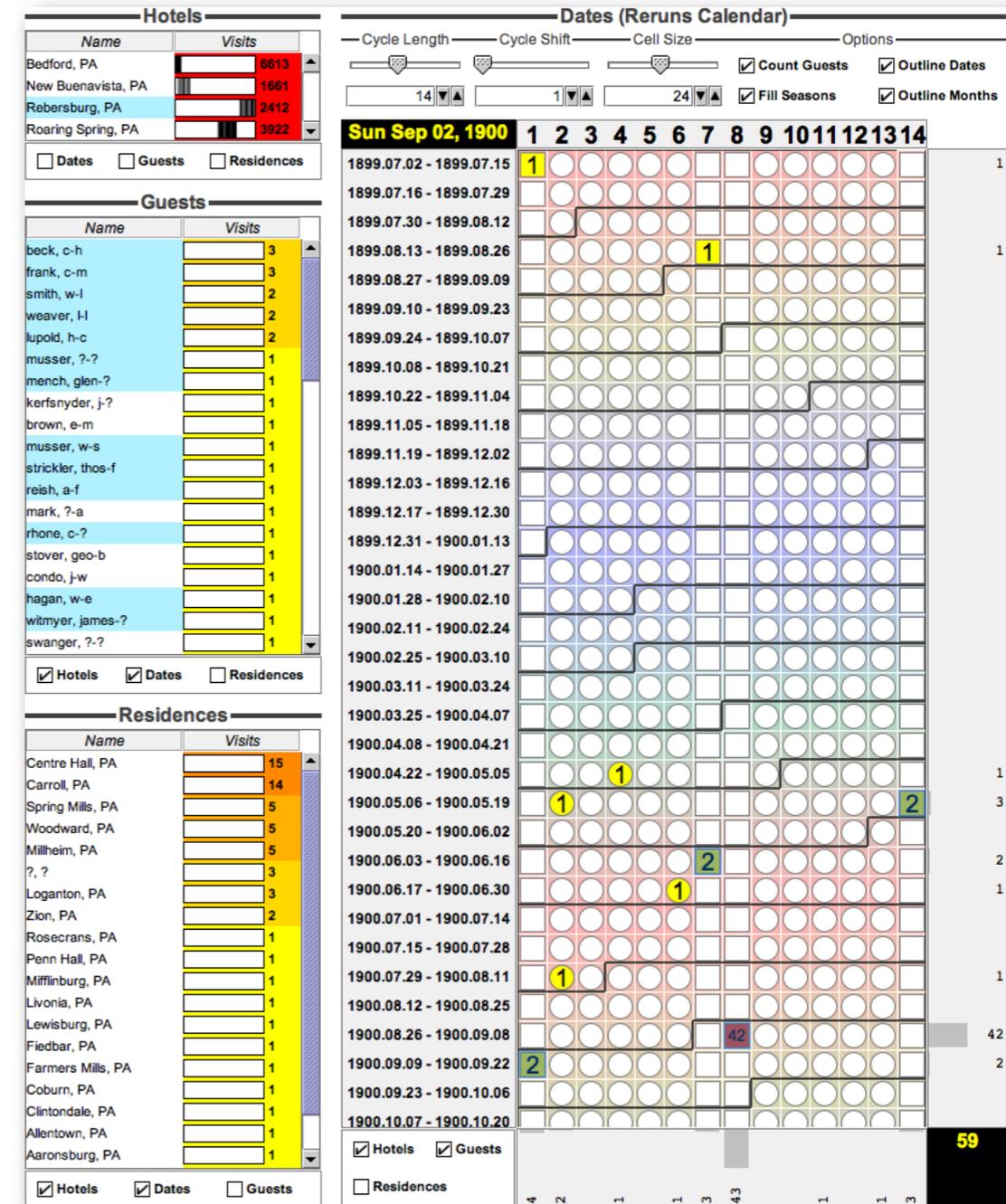
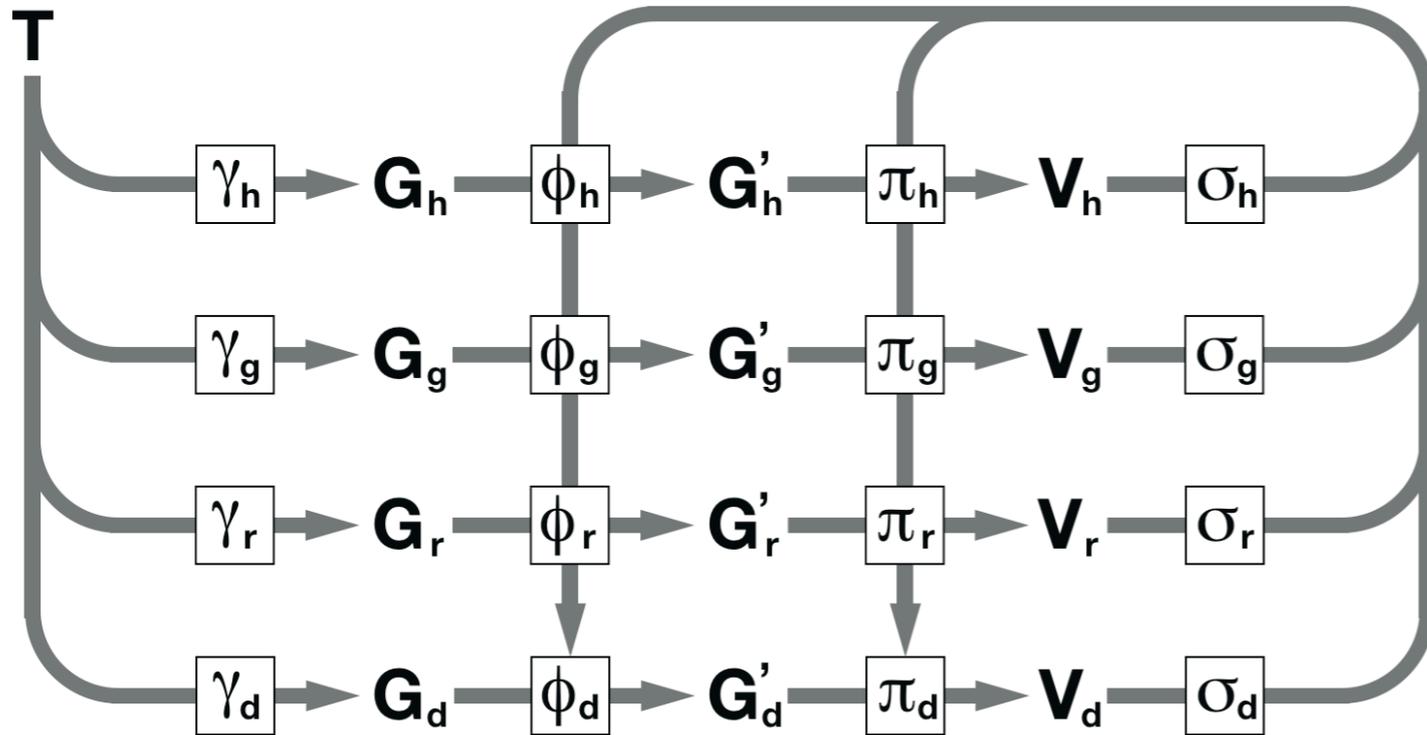
# Pattern: Scatter Plot Matrix



- N-dimensional space as staircase arrangement of 2-D scatter plots [Becker1987]
- Vertical navigation in some plots coordinated with horizontal navigation in others (exploded cube)



# Cross-Filtered Views in the Hotels Visualization



# Data Dissection

methods for interactively expressing sequences of multidimensional set queries by visual-interactively associating unique data values across multiple views

- Multiple views support selection over **sets of unique attribute values** in multiple raw or derived data columns, across one or more tables.
- Attributes are displayed in **dimensionally-appropriate view(s)** that supports a binary categorization of values by selection or navigation.
- Users can **rapidly toggle dependencies** between pairs of views to pose complex drill-down set queries: *effect (show or highlight) only those values in view B that co-occur in the data with the values selected in view A*
- Attributes are displayed in a **entity-relationship view** that shows co-occurrences (relationships) between values (entities).
- Users can **rapidly toggle visibility of attributes and attribute relationships** to dissect the data by slicing in and across data columns
- Analysts can form hypotheses and **follow chains of evidence** by successive selection/deselection and filtering/unfiltering of values.

# If We Don't Remember Our Queries, Are We Doomed to Repeat Them?

- Easy to get distracted by new questions
  - Data dissection techniques are dangerously effective this way
  - Chains of interaction reveal many exciting paths for exploration
- Easy to forget
  - past overall queries
  - earlier query states in a chain of interactions
- So lots of foraging, not enough sense-making
- Need visual history and analytic storybuilding tools
- Major theme of recent visual analytics conferences!
- Most interaction in visualization is simple, general, and happens at a moderate level of abstraction...



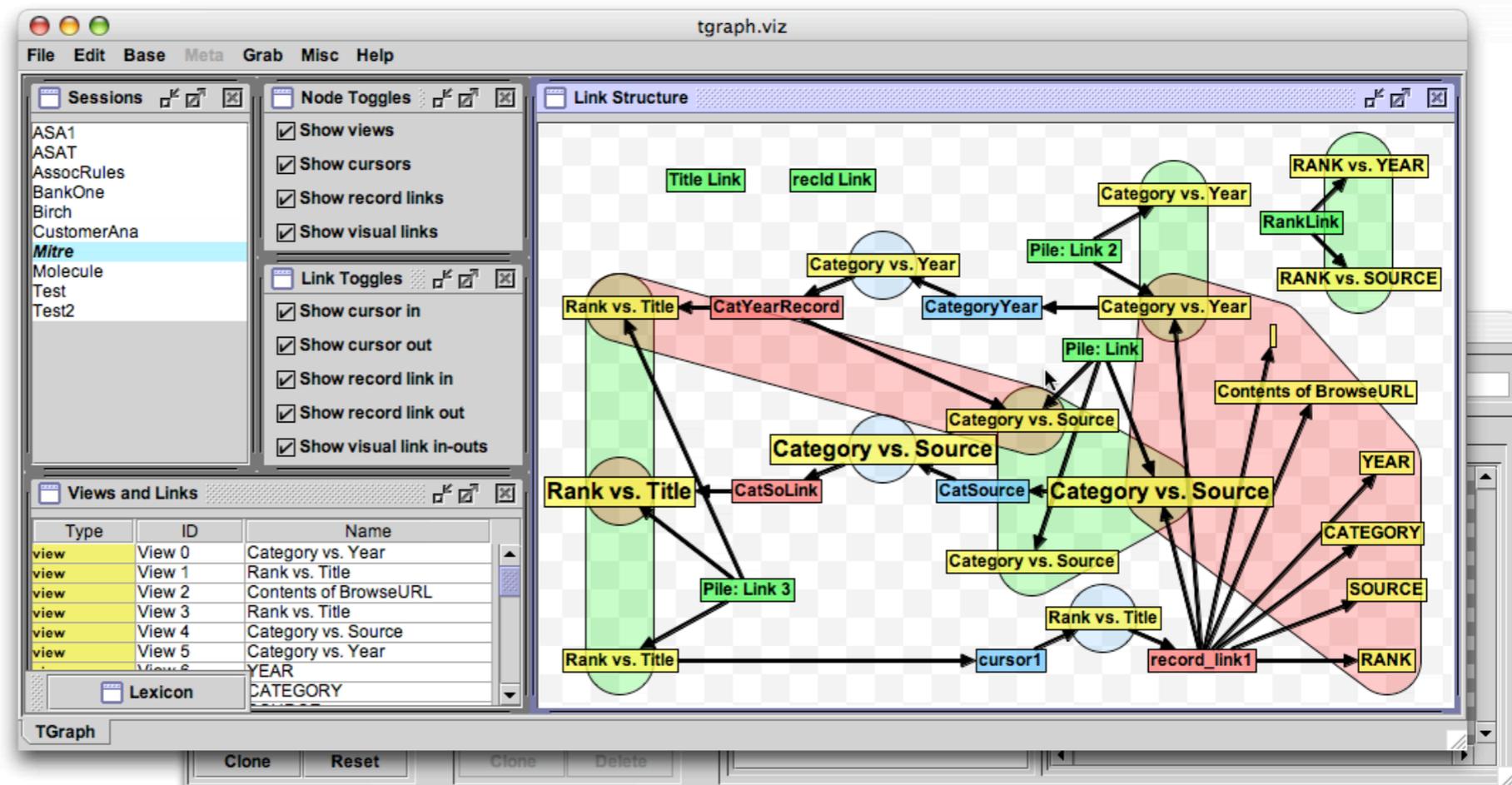
(from "Alice's Adventures in Wonderland" by Lewis Carroll (Charles Lutwidge Dodgson), 1865)

# Visual Analytic Provenance

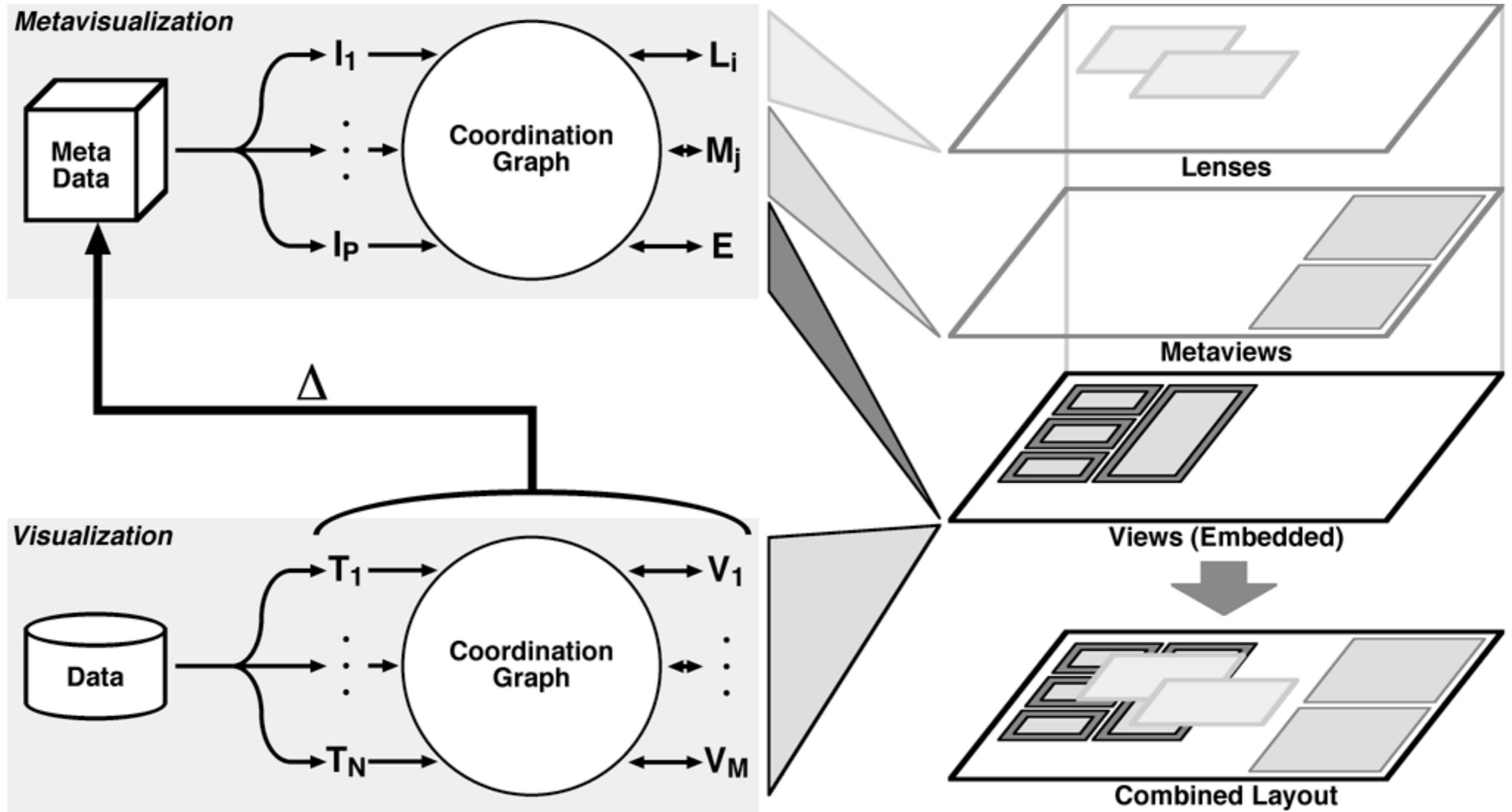
- Capture and restore visual+analytic state
  - Intrinsic information about interface state (engineering, “easy”)
  - Extrinsic information about cognitive state (science, “hard”)
- Idea: Scrubbable Interfaces
  - Across browsing transitions: (in)dependent parameter histories
  - Across building transitions: walking provenance graphs
  - Analytic hyperlinking and replay for teaching, documentation, ...
  - Keyframing

- Represent
  - multiple users
  - levels of skill
  - access control
- Annotation?

- **Visualize it all!**



# Metavisualization



reuse the existing visualization architecture

(a special case: spatialization of evolving data in its native context)

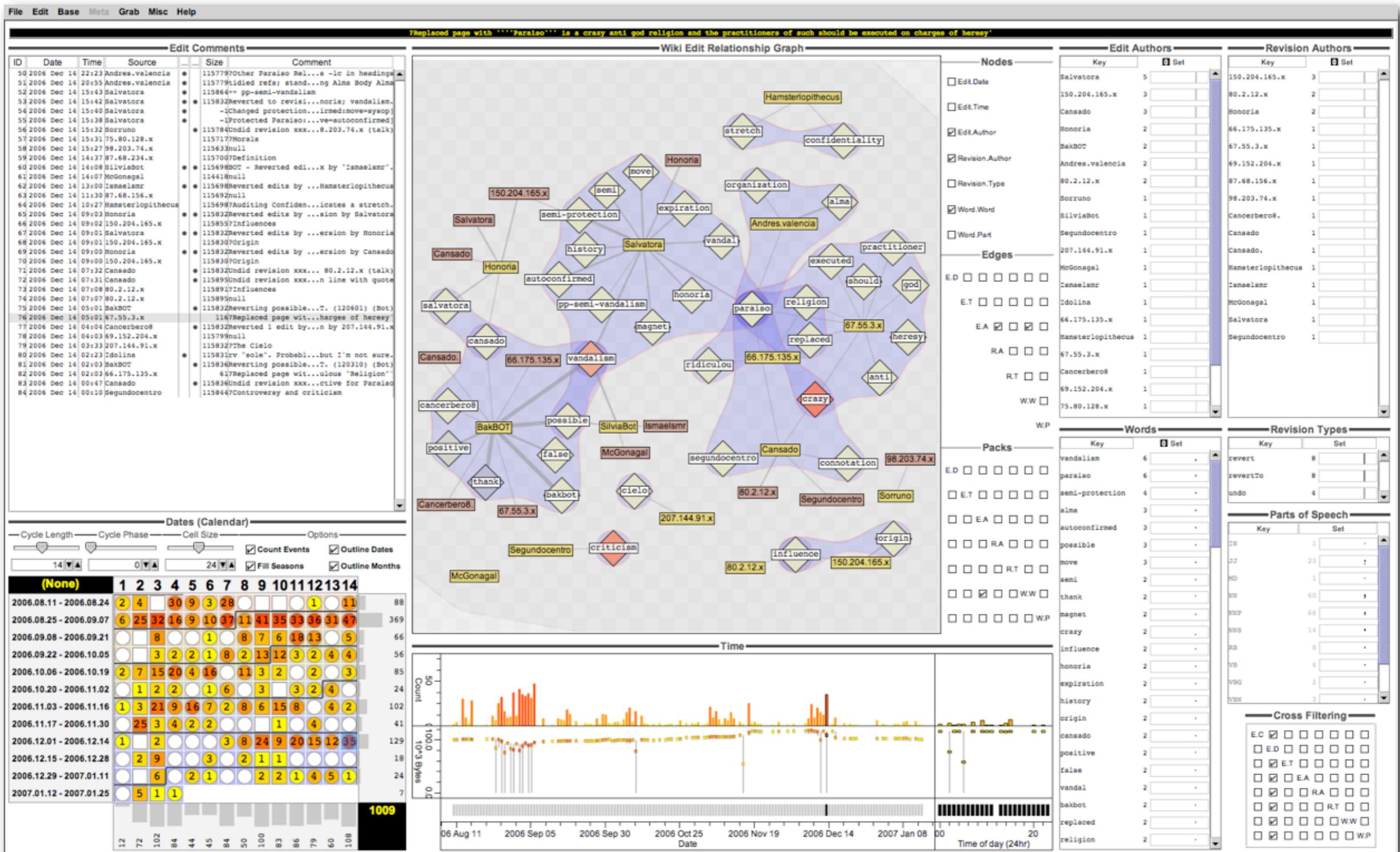


Then she began looking about, and noticed that what could be seen from the old room was quite common and uninteresting, but that all the rest was as different as possible. . . .

“They don’t keep this room so tidy as the other,” thought Alice to herself.

# Idea: Queries to Questions

- “Who, what, where, when” output interface that provides a summary of query sequences
- Map queries and results into a pseudo natural language
  - Designer-specified rule-based text generation
  - Parallel illustration with restorable live snapshots of visual state
  - Visual highlighting of text that involves attribute values and types
  - Inline graphics for enumerating longer sets, à la sparklines
- Data dissection designs are particularly amenable to such mappings?
  - Highly symmetric in form
  - Medium level of abstraction
  - Simple interactions (select item, toggle filter, toggle graph element)
  - Most interactions drive interesting, capturable query transitions



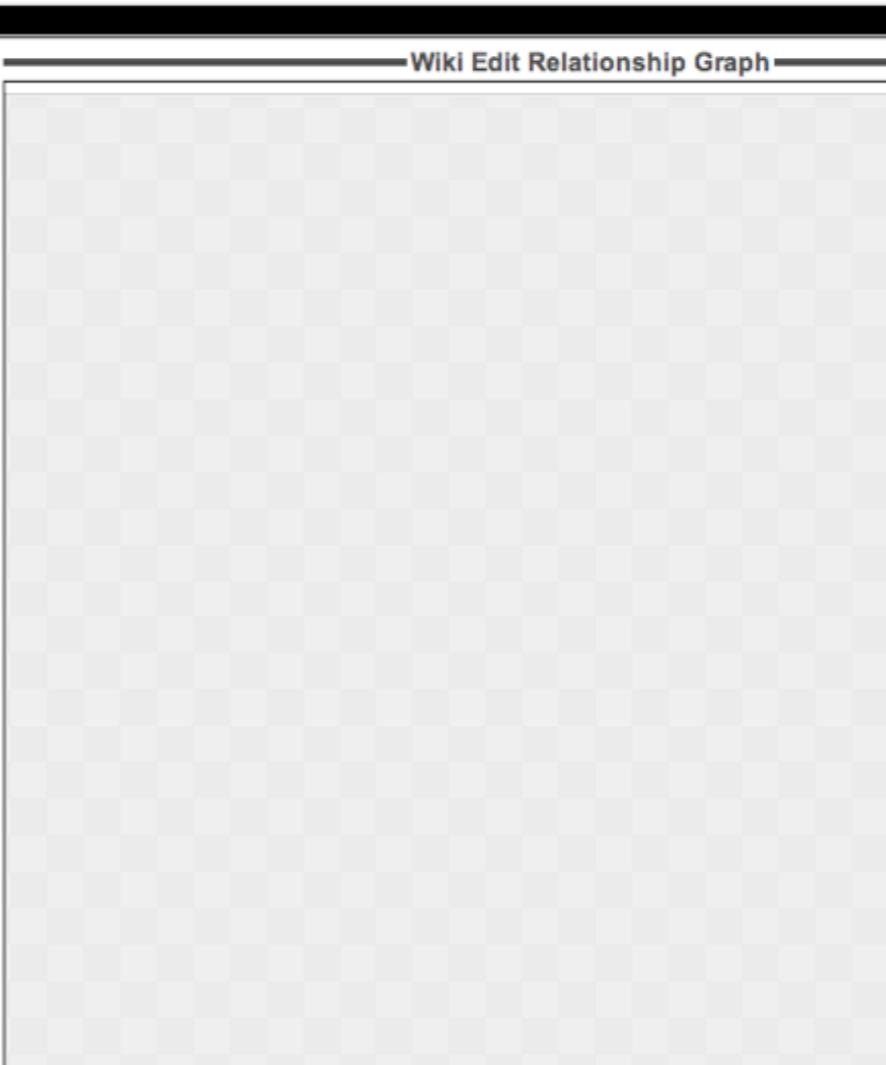
# wiki

a visualization of authors and language over time in a wiki edit history

Data Source: VAST 2008 Challenge, Wiki Edit Mini-Challenge (synthetic)

Visualization Design: Chris Weaver, Chi-chun Pan, Don Pellegrino, Prasenjit Mitra

ID	Date	Time	Source	Size	Comment
1	2007 Jan 15	23:44	Alonzo	100571	Scientific critic...so beliefs - link
2	2007 Jan 14	03:21	Alfonso	100552	External links - ... links (see talk)
3	2007 Jan 13	18:36	Adriano	102461	When first propose...BLP violation, et
4	2007 Jan 13	16:45	DailosTamanca	100959	Undid revision xxx...Gustava's changes
5	2007 Jan 13	15:35	Moisescorral	102461	Undid revision xxx... then you DELETE!
6	2007 Jan 13	14:44	Gustava	100959	Undid revision xxx...l free to join it
7	2007 Jan 13	00:15	Moisescorral	102461	Undid revision xxx...d criteria FIRST!
8	2007 Jan 11	19:26	Gustava	100959	External links - ...- DO NOT EDIT WAR
9	2007 Jan 10	23:51	Strider	102461	Paraiso and psych...lled" per WP:NPOV
10	2007 Jan 10	20:00	Robertocarlosgo	102464	Paraiso and celebrities
11	2007 Jan 10	19:13	Robertocarlosgo	102464	Morals and Ethics
12	2007 Jan 10	16:24	Edemir	102458	Reverted good fait...hology.. using TW
13	2007 Jan 10	09:11	Dragon	102477	null
14	2007 Jan 09	16:17	Selena	102458	Undid revision xxx...undoing own undo.
15	2007 Jan 09	16:06	Selena	102549	Undid revision xxx...d is appropriate.
16	2007 Jan 09	15:54	Gustava	102458	rem off-topic EL t...ection to Paraiso
17	2007 Jan 09	13:41	Harrydelfimo	102549	External links
18	2007 Jan 08	16:00	Gustava	102458	unsourced > sourced
19	2007 Jan 07	18:05	ROMANO	102179	fixed grammar
20	2007 Jan 07	02:09	Abran	102179	See also
21	2007 Jan 06	14:20	Agustin	102171	Auditing confiden... part of the flow
22	2007 Jan 06	11:20	ISMRwiki	102169	Auditing confidentiality



**Nodes**

E.D (Edit.Date)

E.T (Edit.Time)

E.A (Edit.Author)

R.A (Revision.Author)

R.T (Revision.Type)

W.W (Word.Word)

W.P (Word.Part of Speech)

**Edges**

E.D

E.T

E.A

R.A

R.T

W.W

W.P

**Packs**

E.D

E.T

E.A

R.A

R.T

W.W

W.P

Key	Set
12.196.12.x	1
12.196.13.x	2
121.44.3.x	2
124.186.233.x	1
124.189.51.x	1
125.238.243.x	1

Key	Set
12.196.12.x	1
124.186.233.x	1
124.189.51.x	1
128.125.81.x	1
128.174.36.x	1
131.174.244.x	1

Key	Set
revert	121
revertTo	70
undo	86

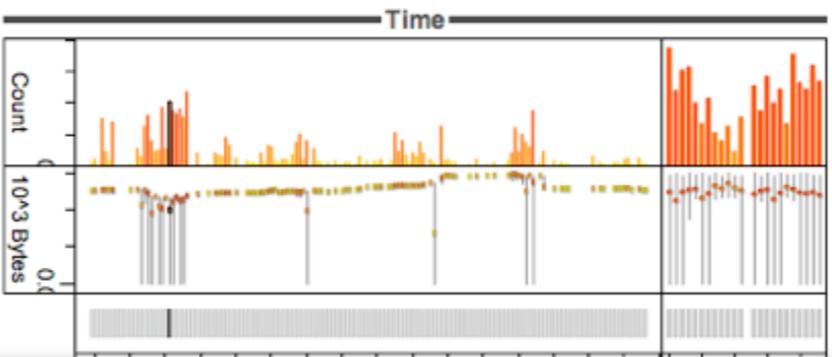
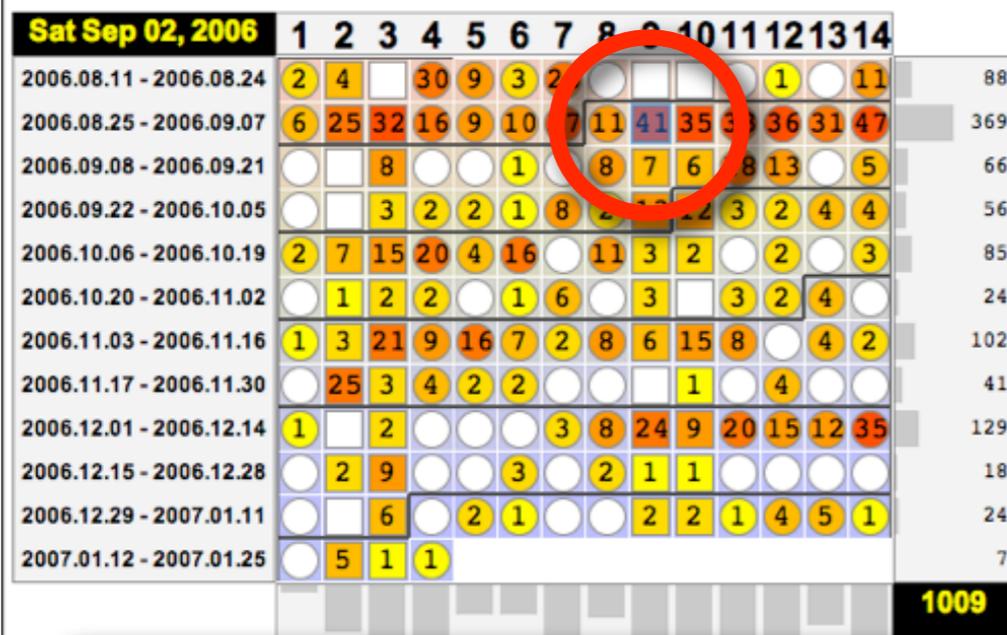
Key	Set
CC	2
CD	5
DZ	7
FW	3
IN	39

**Dates (Calendar)**

Cycle Length: 14 | Cycle Phase: 0 | Cell Size: 24

Count Events  Outline Dates

Fill Seasons  Outline Months



**Cross Filtering**

E.C

E.D

E.T

E.A

R.A

R.T

W.W

W.P

Key	Set
--still	1
--add	1
--lc	1
1960s	1
1st	2

On September 2, 2006

File Edit Base Meta Grab Misc Help

### Edit Comments

ID	Date	Time	Source	Size	Comment
1	2007 Jan 15	23:44	Alonzo	100571	Scientific critic...so beliefs - link
2	2007 Jan 14	03:21	Alfonso	100552	External links - ... links (see talk)
3	2007 Jan 13	18:36	Adriano	102461	When first propose...BLP violation, et
4	2007 Jan 13	16:45	DailosTamanca	100959	Undid revision xxx...Gustava's changes
5	2007 Jan 13	15:35	Moisescorral	102461	Undid revision xxx... then you DELETE!
6	2007 Jan 13	14:44	Gustava	100959	Undid revision xxx...l free to join it
7	2007 Jan 13	00:15	Moisescorral	102461	Undid revision xxx...d criteria FIRST!
8	2007 Jan 11	19:26	Gustava	100959	External links - ...- DO NOT EDIT WAR
9	2007 Jan 10	23:51	Strider	102461	Paraiso and psych...lled" per WP:NPOV
10	2007 Jan 10	20:00	Robertocarlosgo	102464	Paraiso and celebrities
11	2007 Jan 10	19:13	Robertocarlosgo	102464	Morals and Ethics
12	2007 Jan 10	16:24	Edemir	102458	Reverted good fait...hology.. using TW
13	2007 Jan 10	09:11	Dragon	102477	null
14	2007 Jan 09	16:17	Selena	102458	Undid revision xxx...undoing own undo.
15	2007 Jan 09	16:06	Selena	102549	Undid revision xxx...d is appropriate.
16	2007 Jan 09	15:54	Gustava	102458	rem off-topic EL t...ection to Paraiso
17	2007 Jan 09	13:41	Harrydelfimo	102549	External links
18	2007 Jan 08	16:00	Gustava	102458	unsourced > sourced
19	2007 Jan 07	18:05	ROMANO	102179	fixed grammar
20	2007 Jan 07	02:09	Abran	102179	See also
21	2007 Jan 06	14:20	Agustin	102171	Auditing confiden... part of the flow
22	2007 Jan 06	11:20	ISMRwiki	102169	Auditing confidentiality

### Wiki Edit Relationship Graph

### Edit Authors

Key	Set
86.135.211.x	1
Adalberto	1
Alarico	1
Alejo	6
Amado	18
BakBOT	1

### Dates (Calendar)

Cycle Length: 14 | Cycle Phase: 0 | Cell Size: 24

Options:  Count Events  Outline Dates  Fill Seasons  Outline Months

(None)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2006.08.11 - 2006.08.24	2	4		30	9	3	2					1		11
2006.08.25 - 2006.09.07	6	25	32	16	9	10	7	11	41	35	3	36	31	47
2006.09.08 - 2006.09.21			8			1		8	7	6		13		5
2006.09.22 - 2006.10.05			3	2	2	1	8			2	3	2	4	4
2006.10.06 - 2006.10.19	2	7	15	20	4	16		11	3	2		2		3
2006.10.20 - 2006.11.02		1	2	2		1	6		3		3	2	4	
2006.11.03 - 2006.11.16	1	3	21	9	16	7	2	8	6	15	8		4	2
2006.11.17 - 2006.11.30		25	3	4	2	2				1		4		
2006.12.01 - 2006.12.14	1		2				3	8	24	9	20	15	12	35
2006.12.15 - 2006.12.28		2	9		3		2	1	1					
2006.12.29 - 2007.01.11			6		2	1			2	2	1	4	5	1
2007.01.12 - 2007.01.25		5	1	1										

### Time

### Cross filtering

<input type="checkbox"/>	E.C	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	E.D	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	E.T	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	E.A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	R.A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	R.T	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	W.W	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	W.P	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

On September 2, 2006...  
*Who* edits an article?

File Edit Base Meta Grab Misc Help

**Edit Comments**

ID	Date	Time	Source	Size	Comment
1	2007 Jan 15	23:44	Alonzo	100571	?Scientific critic...so beliefs - link
2	2007 Jan 14	03:21	Alfonso	100552	?External links - ... links (see talk)
3	2007 Jan 13	18:36	Adriano	102461	When first propose...BLP violation, et
4	2007 Jan 13	16:45	DailiosTamanca	100959	Undid revision xxx...Gustava's changes
5	2007 Jan 13	15:35	Moisescorral	102461	Undid revision xxx... then you DELETE!
6	2007 Jan 13	14:44	Gustava	100959	Undid revision xxx...l free to join it
7	2007 Jan 13	00:15	Moisescorral	102461	Undid revision xxx...d criteria FIRST!
8	2007 Jan 11	19:26	Gustava	100959	?External links - ...- DO NOT EDIT WAR
9	2007 Jan 10	23:51	Strider	102461	?Paraiso and psych...lled' per WP:NPOV
10	2007 Jan 10	20:00	Robertocarlosgo	102464	?Paraiso and celebrities
11	2007 Jan 10	19:13	Robertocarlosgo	102464	?Morals and Ethics
12	2007 Jan 10	16:24	Edemir	102458	Reverted good fait...hology.. using TW
13	2007 Jan 10	09:11	Dragon	102477	null
14	2007 Jan 09	16:17	Selena	102458	Undid revision xxx...undoing own undo.
15	2007 Jan 09	16:06	Selena	102549	Undid revision xxx...d is appropriate.
16	2007 Jan 09	15:54	Gustava	102458	rem off-topic EL t...ection to Paraiso
17	2007 Jan 09	13:41	Harrydelfimo	102549	?External links
18	2007 Jan 08	16:00	Gustava	102458	unsourced > sourced
19	2007 Jan 07	18:05	ROMANO	102179	fixed grammar
20	2007 Jan 07	02:09	Abran	102179	?See also
21	2007 Jan 06	14:20	Agustin	102171	?Auditing confiden... part of the flow
22	2007 Jan 06	11:20	ISMRwiki	102169	?Auditing confidentiality

**Wiki Edit Relationship Graph**

**Nodes**

- E.D (Edit.Date)
- E.T (Edit.Time)
- E.A (Edit.Author)
- R.A (Revision.Author)
- R.T (Revision.Type)
- W.W (Word.Word)
- W.P (Word.Part of Speech)

**Edges**

- E.D
- E.T
- E.A
- R.A
- R.T
- W.W
- W.P

**Packs**

- E.D
- E.T
- E.A
- R.A
- R.T
- W.W
- W.P

**Ed Authors**

Key	Set
Amado	18
Alejo	6
Kurrop	
Rm99	4
VictoriaV	2
86.135.211.x	1

**Revision Authors**

Key	Set
12.196.12.x	1
124.186.233.x	1
124.189.51.x	1
128.125.81.x	1
128.174.36.x	1
131.174.244.x	1

**Revision Types**

Key	Set
revert	121
revertTo	70
undo	86

**Parts of Speech**

Key	Set
CC	2
CD	5
DT	7
PW	3
IN	39

**Words**

Key	Set
--still	1
--add	1
--lc	1
1960s	1
1st	2

**Dates (Calendar)**

Cycle Length: 14, Cycle Phase: 0, Cell Size: 24

Options:  Count Events,  Outline Dates,  Fill Seasons,  Outline Months

(None)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
2006.08.11 - 2006.08.24	2	4		30	9	3	28					1		11	88
2006.08.25 - 2006.09.07	6	25	32	16	9	10	37	11	41	35	33	36	31	47	369
2006.09.08 - 2006.09.21			8			1		8	7	6	18	13		5	66
2006.09.22 - 2006.10.05			3	2	2	1	8	2	13	12	3	2	4	4	56
2006.10.06 - 2006.10.19	2	7	15	20	4	16		11	3	2			2	3	85
2006.10.20 - 2006.11.02		1	2	2		1	6		3		3	2	4		24
2006.11.03 - 2006.11.16	1	3	21	9	16	7	2	8	6	15	8		4	2	102
2006.11.17 - 2006.11.30		25	3	4	2	2				1		4			41
2006.12.01 - 2006.12.14	1		2				3	8	24	9	20	15	12	35	129
2006.12.15 - 2006.12.28		2	9			3		2	1	1					18
2006.12.29 - 2007.01.11			6		2	1			2	2	1	4	5	1	24

**Time**

Count: 10v3 B

**Cross Filtering**

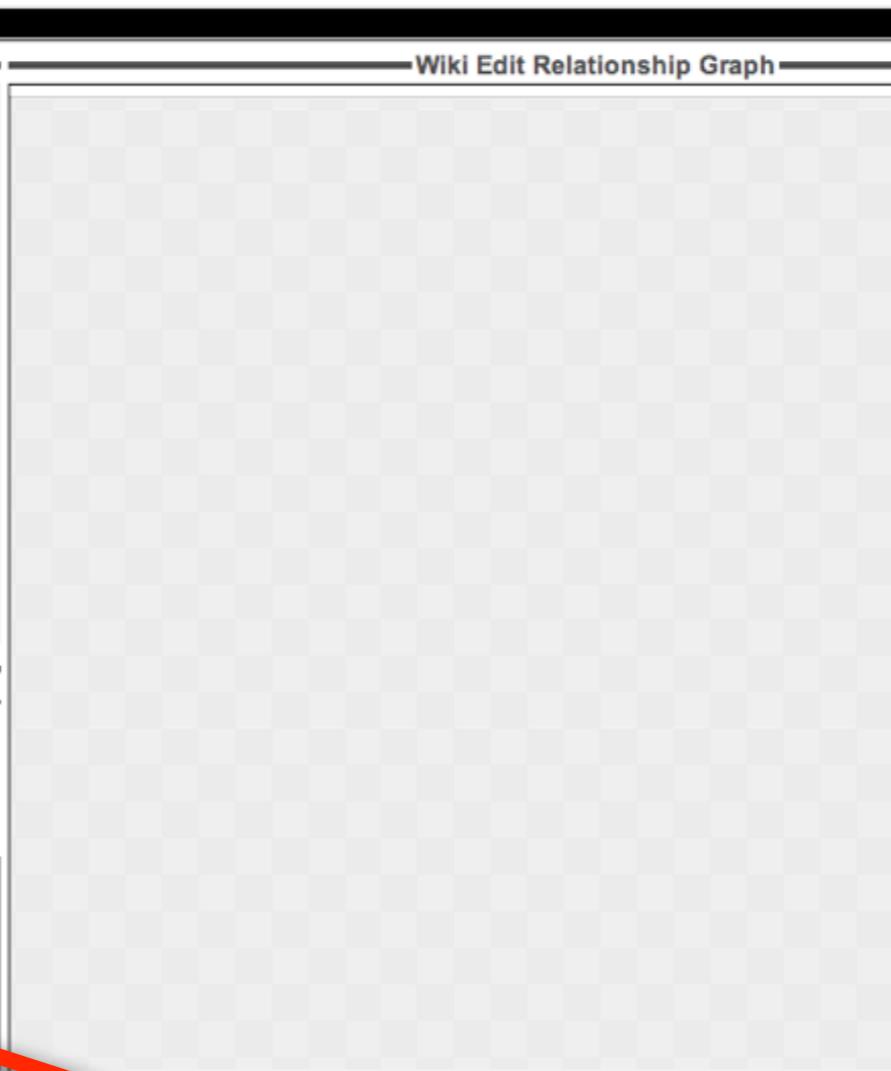
- E.C
- E.D
- E.T
- E.A
- R.A
- R.T
- W.W
- W.P

On September 2, 2006...

~~Who edits an article?~~

Who edits the most articles?

ID	Date	Time	Source	Size	Comment
1	2007 Jan 15	23:44	Alonzo	100571	Scientific critic...so beliefs - link
2	2007 Jan 14	03:21	Alfonso	100552	External links - ... links (see talk)
3	2007 Jan 13	18:36	Adriano	102461	When first propose...BLP violation, et
4	2007 Jan 13	16:45	DailiosTamanca	100959	Undid revision xxx...Gustava's changes
5	2007 Jan 13	15:35	Moisescorral	102461	Undid revision xxx... then you DELETE!
6	2007 Jan 13	14:44	Gustava	100959	Undid revision xxx...l free to join it
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11	2007 Jan 10	19:13	Robertocarlosgo	102464	Morals and Ethics
12	2007 Jan 10	16:24	Edemir	102458	Reverted good fait...hology.. using TW
13	2007 Jan 10	09:11	Dragon	102477	null
14	2007 Jan 09	16:17	Selena	102458	Undid revision xxx...undoing own undo.
15	2007 Jan 09	16:06	Selena	102549	Undid revision xxx...d is appropriate.
16	2007 Jan 09	15:54	Gustava	102458	rem off-topic EL t...ection to Paraiso
17	2007 Jan 09	13:41	Harrydelfimo	102549	External links
18	2007 Jan 08	16:00	Gustava	102458	unsourced > sourced
19	2007 Jan 07	18:05	ROMANO	102179	fixed grammar
20	2007 Jan 07	02:09	Abran	102179	See also
21	2007 Jan 06	14:20	Agustin	102171	Auditing confiden... part of the flow
22	2007 Jan 06	11:20	ISMRwiki	102169	Auditing confidentiality



### Edit Authors

Key	Set
Amado	18
Alejo	6
Kurrop	5
Rm99	4
VictoriaV	2
86.135.211.x	1

### Revision Authors

Key	Set
12.196.12.x	1
124.186.233.x	1
124.189.51.x	1
128.125.81.x	1
128.174.36.x	1
131.174.244.x	1

### Revision Types

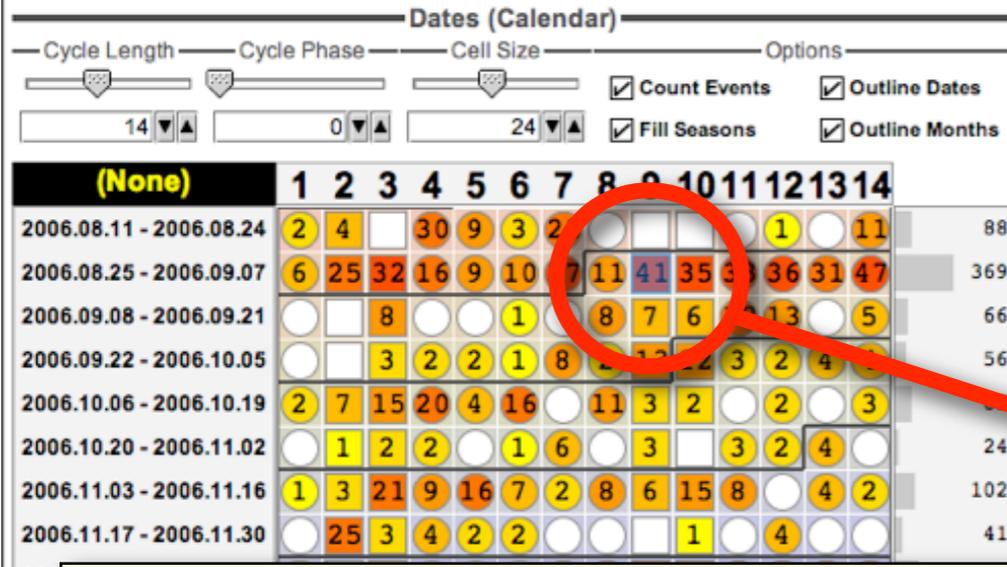
Key	Set
revert	121
revertTo	70
undo	86

### Parts of Speech

Key	Set
CC	2
CD	5
DT	7
PW	3
IN	39

### Words

Key	Set
ist	2
accordance	1
added	15
after	1
alma	1



On **September 2, 2006**...

~~Who edits an article?~~

**Who edits the most articles?**

and

**What words appear in comments?**

The screenshot shows a software interface for analyzing Wikipedia edit data. The main components are:

- Edit Comments Table:** A table with columns for ID, Date, Time, Source, Size, and Comment. It lists various edit events from January 2007.
- Dates (Calendar):** A calendar view showing edit counts for different time periods. A red circle highlights the date September 2, 2006, which has a count of 41.
- Wiki Edit Relationship Graph:** A large empty area intended for visualizing relationships between different edit types.
- Filter Panels:**
  - Edit Authors:** A panel with a table of author names and their edit counts. A red circle highlights this panel.
  - Words:** A panel with a table of words and their counts. A red circle highlights this panel.
  - Other panels:** Edges, Packs, Cross Filtering, and Parts of Speech.

A red arrow points from the calendar view to the 'Words' panel, indicating a data flow or analysis step.

On September 2, 2006...

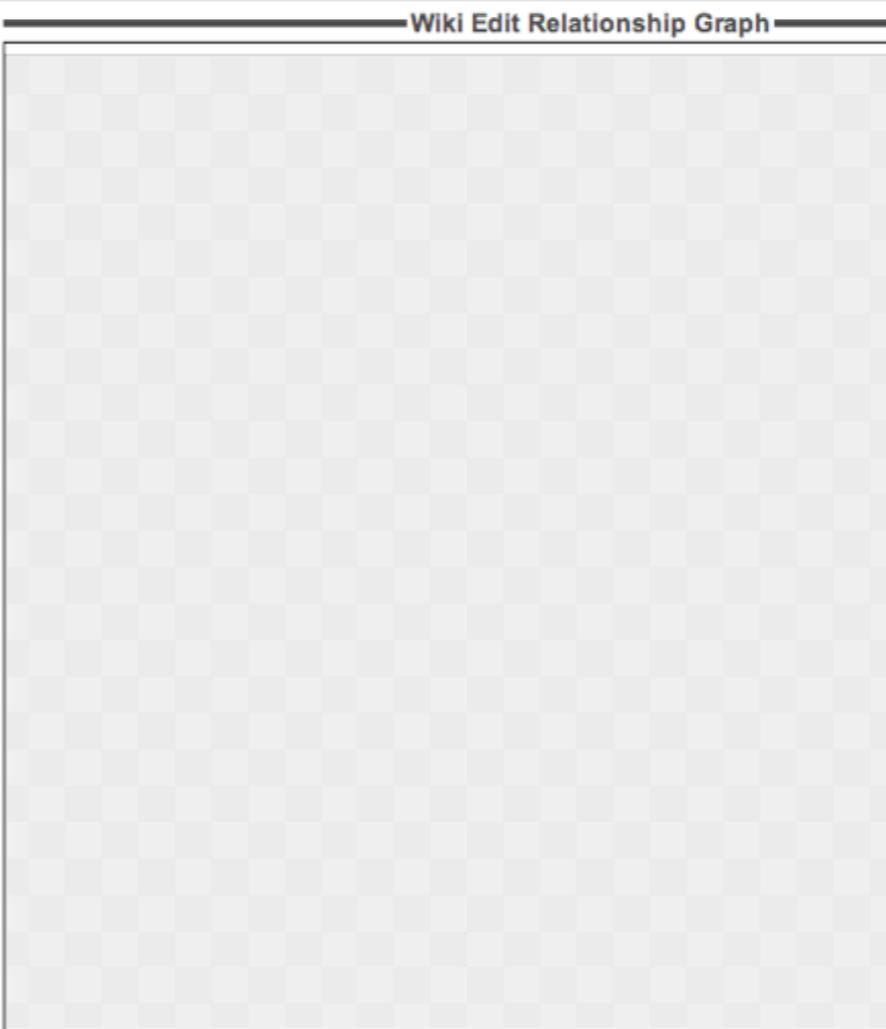
~~Who~~ edits an article?

Who edits the most articles?

For editor Amado,

What words appear in comments?

ID	Date	Time	Source	Size	Comment
1	2007 Jan 15	23:44	Alonzo	100571	Scientific critic...so beliefs - link
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7	2007 Jan 13	00:15	Moisescorral	102461	Undid revision xxx...d criteria FIRST!
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10	2007 Jan 10	20:00	Robertocarlosgo	102464	Paraiso and celebrities
11	2007 Jan 10	19:13	Robertocarlosgo	102464	Morals and Ethics
12	2007 Jan 10	16:24	Edemir	102458	Reverted good fait...hology.. using TW
13	2007 Jan 10	09:11	Dragon	102477	null
14	2007 Jan 09	16:17	Selena	102458	Undid revision xxx...undoing own undo.
15	2007 Jan 09	16:06	Selena	102549	Undid revision xxx...d is appropriate.
16	2007 Jan 09	15:54	Gustava	102458	rem off-topic EL t...ection to Paraiso
17	2007 Jan 09	13:41	Harrydelfimo	102549	External links
18	2007 Jan 08	16:00	Gustava	102458	unsourced > sourced
19	2007 Jan 07	18:05	ROMANO	102179	fixed grammar
20	2007 Jan 07	02:09	Abran	102179	See also
21	2007 Jan 06	14:20	Agustin	102171	Auditing confiden... part of the flow
22	2007 Jan 06	11:20	ISMRwiki	102169	Auditing confidentiality



**Edit Authors**

Key	Set
Amado	18
Alejo	6
Kurrop	5
Rm99	4
VictoriaV	2
86.135.211.x	1

**Revision Authors**

Key	Set
12.196.12.x	1
124.186.233.x	1
124.189.51.x	1
128.125.81.x	1
128.174.36.x	1
131.174.244.x	1

**Revision Types**

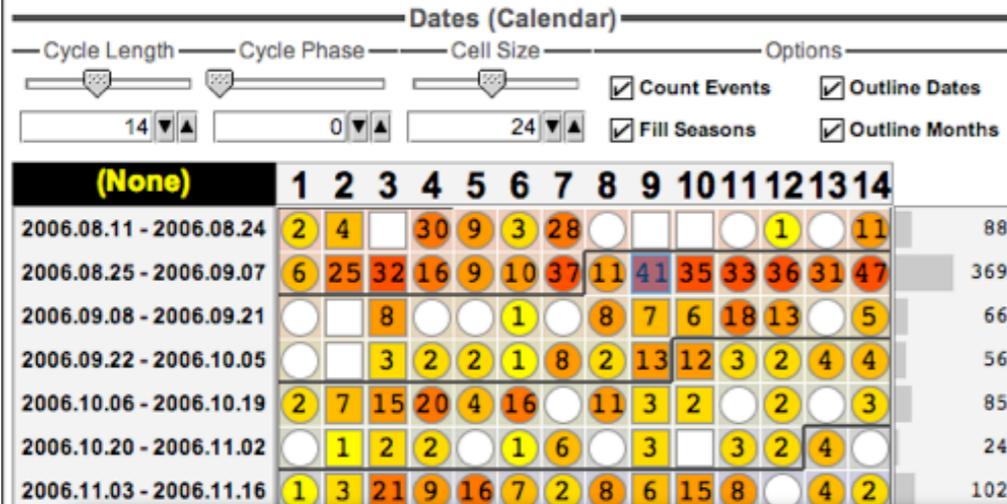
Key	Set
revert	121
revertTo	70
undo	86

**Parts of Speech**

Key	Set
CC	2
CD	5
DT	7
PW	3
IN	3

**Words**

Key	Set
paraiso	9
added	6
belief	4
movement	3
intro	3



On September 2, 2006...

~~Who edits an article?~~

Who edits the most articles?

For editor Amado,

What words appear in comments?

For words paraiso, belief, or movement,

The screenshot shows a software interface with several panels:

- Edit Comments:** A table with columns: ID, Date, Time, Source, Size, Comment. It lists various comments from 2007.
- Dates (Calendar):** A calendar view for 2006 with a grid of days. The date 2006.09.02 is highlighted.
- Wiki Edit Relationship Graph:** A large empty grid area.
- Nodes:** A list of nodes with checkboxes for E.D, E.T, E.A, R.A, R.T, W.W, W.P.
- Edges:** A grid of checkboxes for E.D, E.T, E.A, R.A, R.T, W.W, W.P.
- Packs:** A grid of checkboxes for E.D, E.T, E.A, R.A, R.T, W.W, W.P.
- Cross Filtering:** A grid of checkboxes for E.C, E.D, E.T, E.A, R.A, R.T, W.W, W.P.
- Edit Authors:** A table with columns: Key, Set. It lists authors like Amado, Adalberto, Alejo.
- Revision Types:** A table with columns: Key, Set. It lists types like revert, revertTo, undo.
- Parts of Speech:** A table with columns: Key, Set. It lists parts of speech like CC, CD, DT, FW, IN.
- Words:** A table with columns: Key, Set. It lists words like paraiso, added, belief, movement, intro.

On September 2, 2006...

For editor Amado,

*What words* appear in comments?

and

For words paraiso, belief, or movement,

*Who* edits them in comments?

The screenshot shows a complex data analysis tool. On the left, there's a table of edit comments with columns for ID, Date, Time, Source, Size, and Comment. Below it is a calendar view for August to December 2006. The central part is a 'Wiki Edit Relationship Graph' showing nodes for editors (Alejo, Amado, Adalberto) and words (paraiso, belief, movement). To the right, there are several filter panels: 'Edit Authors', 'Revision Authors', 'Revision Types', 'Parts of Speech', 'Cross Filtering', and 'Words'. Red circles and arrows highlight the 'E.A (Edit.Author)' checkbox in the Nodes panel, the names 'Amado', 'Adalberto', and 'Alejo' in the graph, and the words 'paraiso', 'belief', and 'movement' in the Words panel.

On September 2, 2006...

For editors Amado, Adalberto, or Alejo and words paraiso, belief, or movement, Who edits which words?

# Summary

- The Goals
  - “Free association” in visual information foraging
  - Exploration of relationships between ad hoc categories
  - Mixed dimensional analysis: combinations of space+time+abstract
- The Directions
  - Questions: Develop techniques for visual-interactively expressing sequences of multidimensional spatial+temporal+abstract queries
  - Narrations: Develop a “lab notebook” for recording, recalling, restoring, and relating queries and query sequences as questions
- The Results (so far)
  - Reusable high-level patterns for visual-interactive synthesis
  - A variety of concrete examples with demonstrated utility
  - Happy domain experts (with publications)
  - Ideas for narrating the exploration and analysis process



Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, “and what is the use of a book,” thought Alice “without pictures or conversation?”

Thanks!  
Queries?