Interaction II

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CS 294-10: Visualization
Fall 2014

Announcements

Assignment 3: Visualization Software

Create a **small** interactive visualization application – you choose data domain and visualization technique.

1. Describe data and storyboard interface
2. Implement interface and produce final writeup
3. Submit the application and a final writeup on the wiki

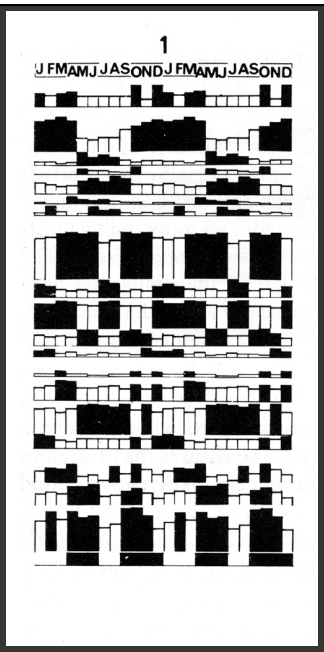
Can work alone or in pairs

Final write up due before class on **Oct 15, 2014**

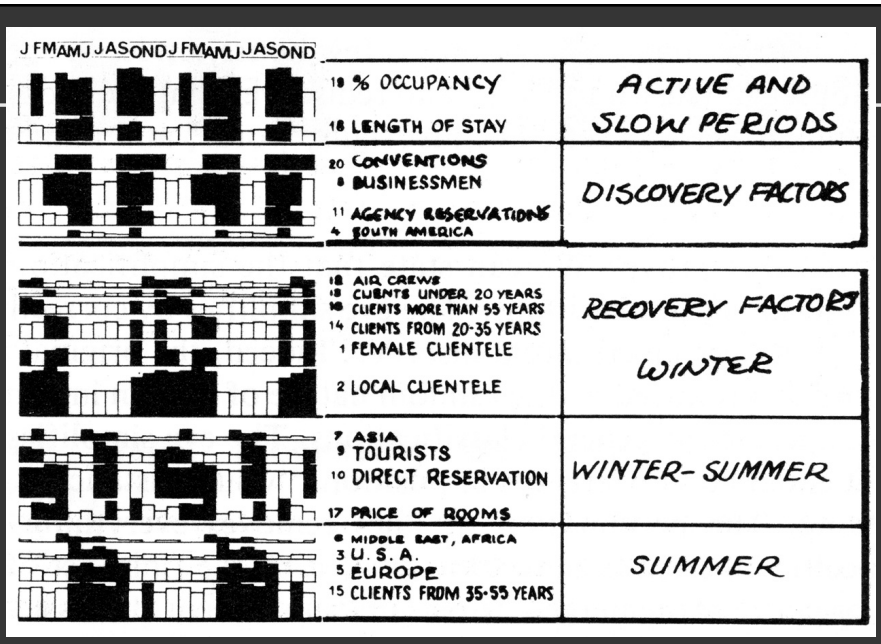
Last Time: Interaction

J	F	M	A	M	J	J	A	S	O	N	D		
26	21	26	28	20	20	20	20	20	40	15	40	1	% CLIENTELE FEMALE
69	70	77	71	37	36	39	39	55	60	68	72	2	% —〃— LOCAL
7	6	3	6	23	14	19	14	9	6	8	8	3	% —〃— U.S.A.
0	0	0	0	8	6	6	4	2	12	0	0	4	% —〃— SOUTH AMERICA
20	15	14	15	23	27	22	30	27	19	19	17	5	% —〃— EUROPE
1	0	0	8	6	4	6	4	2	1	0	1	6	% —〃— M.EAST, AFRICA
3	10	6	0	3	13	8	9	5	2	5	2	7	% —〃— ASIA
78	80	85	86	85	87	70	76	87	85	87	80	8	% BUSINESSMEN
22	20	15	14	15	13	30	24	13	15	13	20	9	% TOURISTS
70	70	75	74	69	68	74	75	68	68	64	75	10	% DIRECT RESERVATIONS
20	18	19	17	27	27	19	19	26	27	21	15	11	% AGENCY ———〃———
10	12	6	9	4	5	7	6	6	5	15	10	12	% AIR CREWS
2	2	4	2	2	1	1	2	2	4	2	5	13	% CLIENTS UNDER 20 YEARS
25	27	37	35	25	25	27	28	24	30	24	30	14	% —〃— 20-35 —〃—
48	49	42	48	54	55	53	51	55	46	55	43	15	% —〃— 35-55 —〃—
25	22	17	15	19	19	19	19	19	20	19	22	16	% —〃— MORE THAN 55 —〃—
163	167	166	174	152	155	145	170	157	174	165	156	17	PRICE OF ROOMS
1.65	1.71	1.65	1.91	1.90	2.	1.54	1.60	1.73	1.82	1.66	1.44	18	LENGTH OF STAY
67	82	70	83	74	77	56	62	90	92	78	55	19	% OCCUPANCY
			X	X	X			X	X	X	X	20	CONVENTIONS

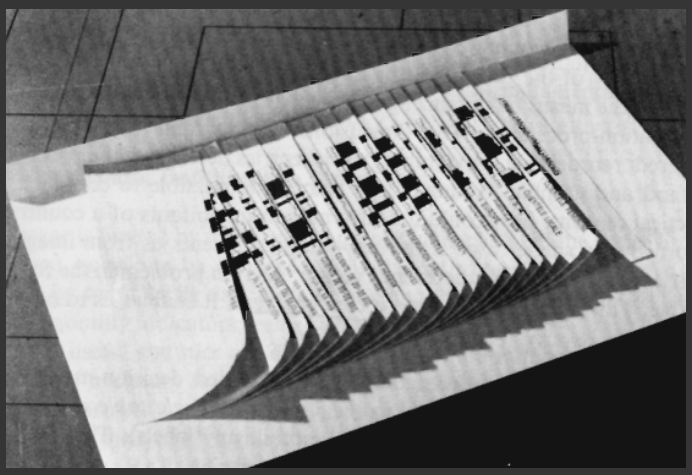
[Graphics and Graphic Information Processing, Bertin 81]



[Graphics and Graphic Information Processing, Bertin 81]



[Graphics and Graphic Information Processing, Bertin 81]

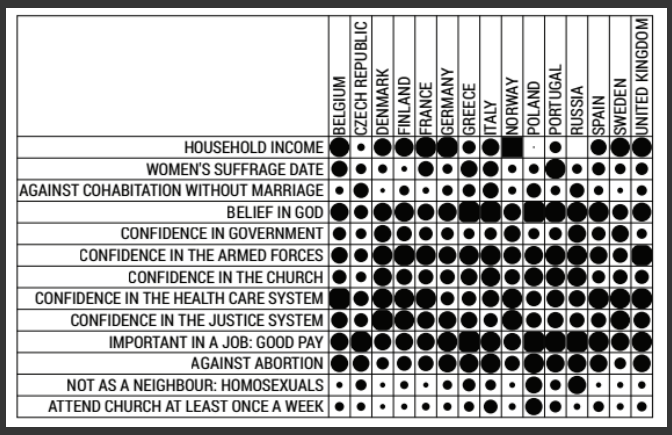


[Graphics and Graphic Information Processing, Bertin 81]

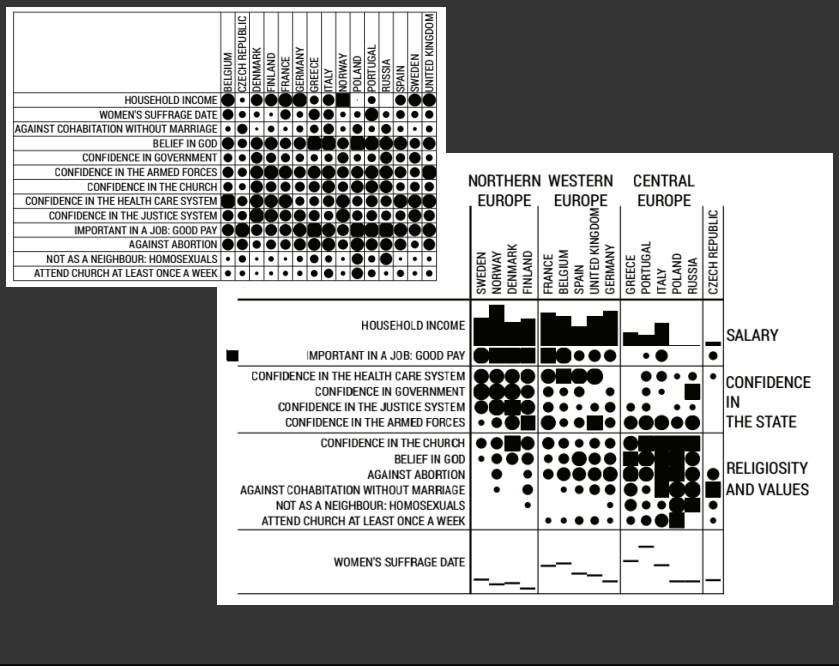
Sorting

Sorting by rows *and* columns

When might this be useful?



[Perin, Dragicevic, and Fekete 2014]



Bertin Matrices

Research question

⬇

Table

⬇

1. Encode table cells visually
2. Group similar rows and columns to reveal patterns

Group similar rows and columns

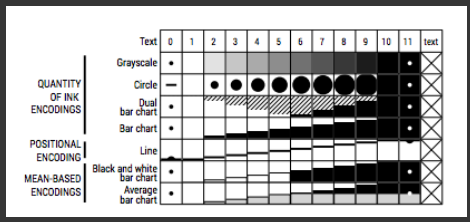
Choose a row with a particular visual aspect. Move to extremity of matrix.

Move similar rows close, opposite rows to bottom. (Creates two opposing groups and a middle group)

Repeat for columns

Iterate

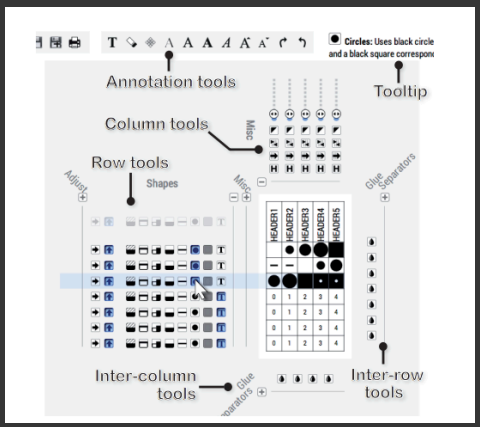
Visual encodings



Quantity of ink is proportional to the normalized data value

Reordering methods

Manual

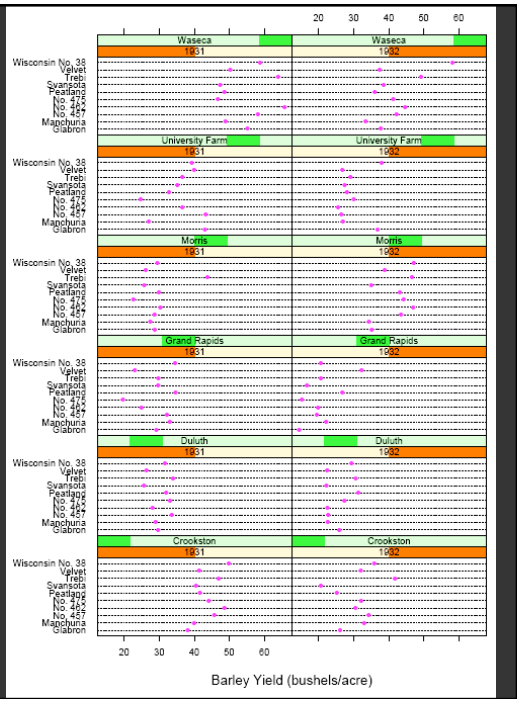


Automatic

bertifier.com

Trellis

[Becker, Cleveland, and Shyu 96]

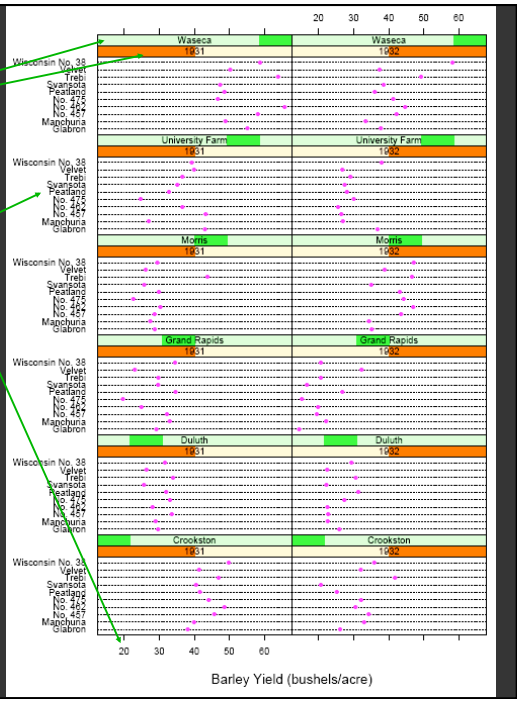


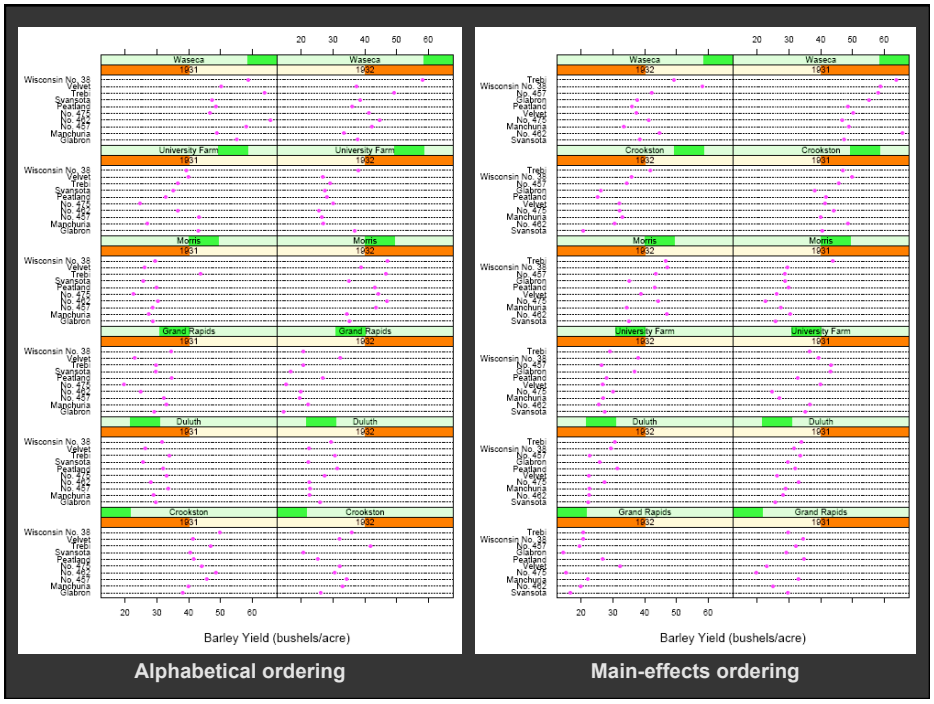
Trellis

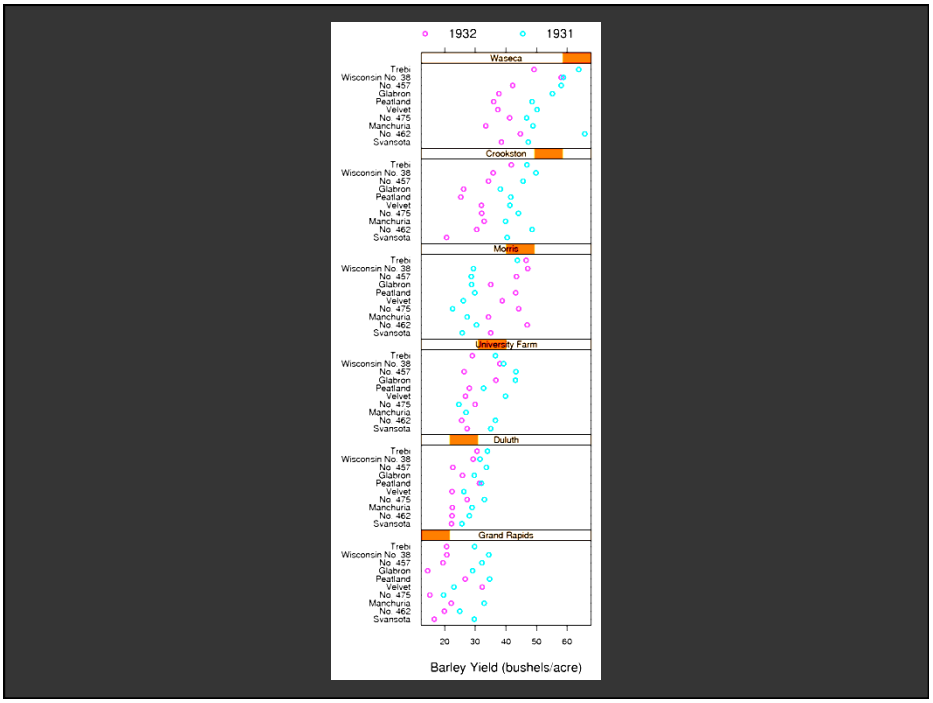
[Becker, Cleveland, and Shyu 96]

Condition variables
location, year

Panel variables
type, yield




Waseca
1931
1932
University Farm
Morris
Grand Rapids
Duluth
Crookston
Wisconsin No. 38
Velvet
Trebi
Svansota
Peatland
No. 475
No. 462
No. 457
Manchuria
Glabron
20
30
40
50
60
Barley Yield (bushels/acre)
Alphabetical ordering
Main-effects ordering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Manchuria
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Svansota
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40
50
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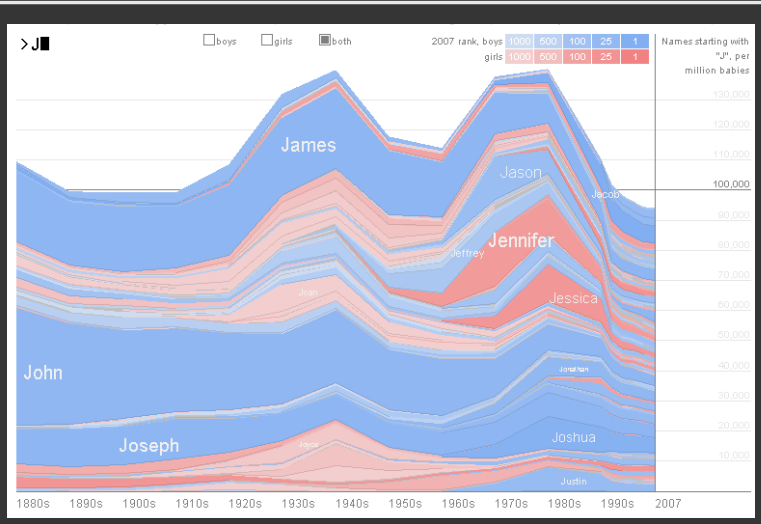
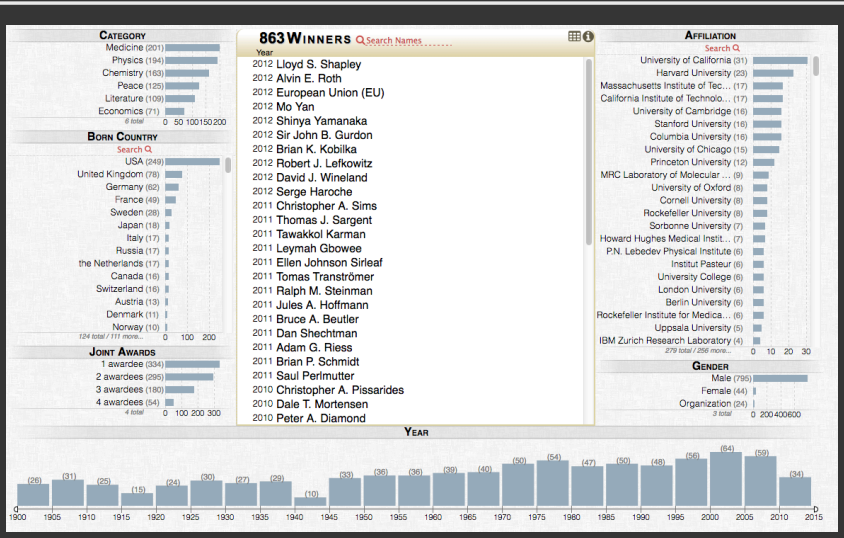
Dynamic Queries

NameVoyager



http://www.babynamewizard.com/voyager

Keshif



https://www.cs.umd.edu/hcil/keshif/

Direct manipulation

1. Visual representation of objects and actions
2. Rapid, incremental and reversible actions
3. Selection by pointing (not typing)
4. Immediate and continuous display of results

How quick does in need to be? *(rules of thumb)*

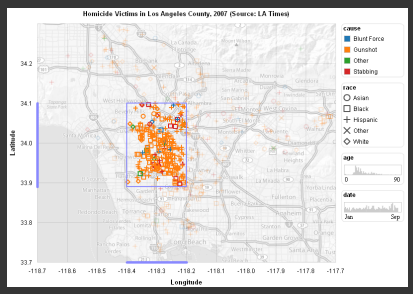
- 0.1s: Instantaneous
- 1.0s: Flow of thought uninterrupted
- 10s: Keeping user's attention on dialogue

[Miller 1968]

Generalized Selection

Visual Queries

Model selections as declarative queries



$(-118.371 \leq lon \text{ AND } lon \leq -118.164) \text{ AND } (33.915 \leq lat \text{ AND } lat \leq 34.089)$

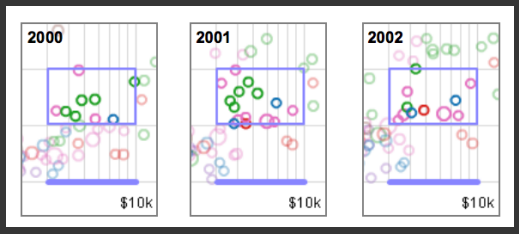
Visual Queries

Model selections as declarative queries

Applicable to dynamic, time-varying data

Retarget selection across visual encodings

Perform operations on query structure



"Select items like this one."

Generalized Selection

Point to an example and define an abstraction based on one or more properties [Clark, Brennan]

"Blue like this"
"The same shape as that"

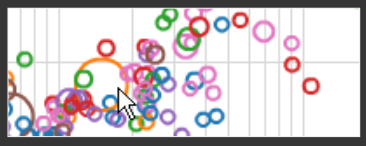
Abstraction may occur over multiple levels

This is not a sentence.

Generalized Selection

Provide *generalization mechanisms* that enable users to *expand a selection query* along *chosen dimensions* of interest

Expand selections via query relaxation



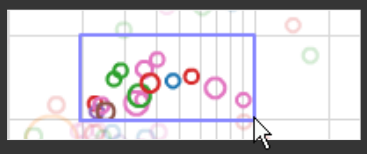
Interactor

Query Builder

Query Builder

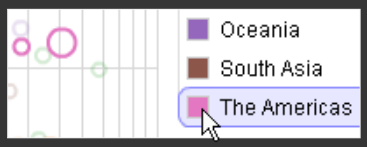
Click: Select Items

(id = 'China')



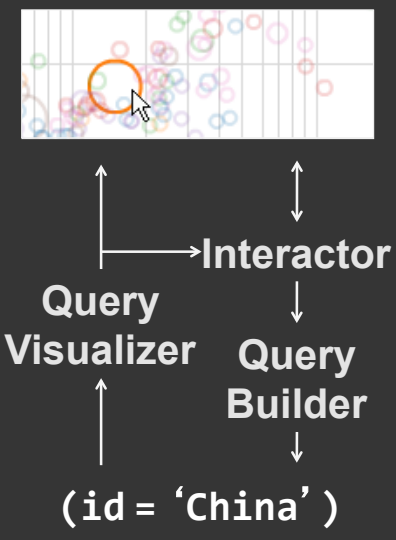
Drag: Select Range

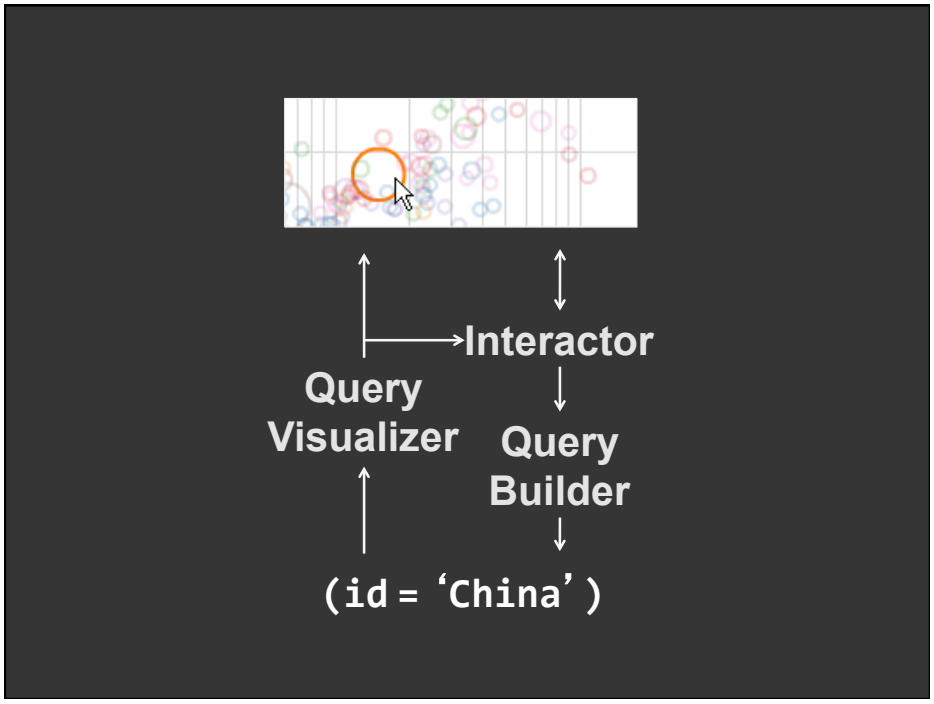
(2000 < gni AND gni < 10000) AND (.1 < internet AND internet < .2)

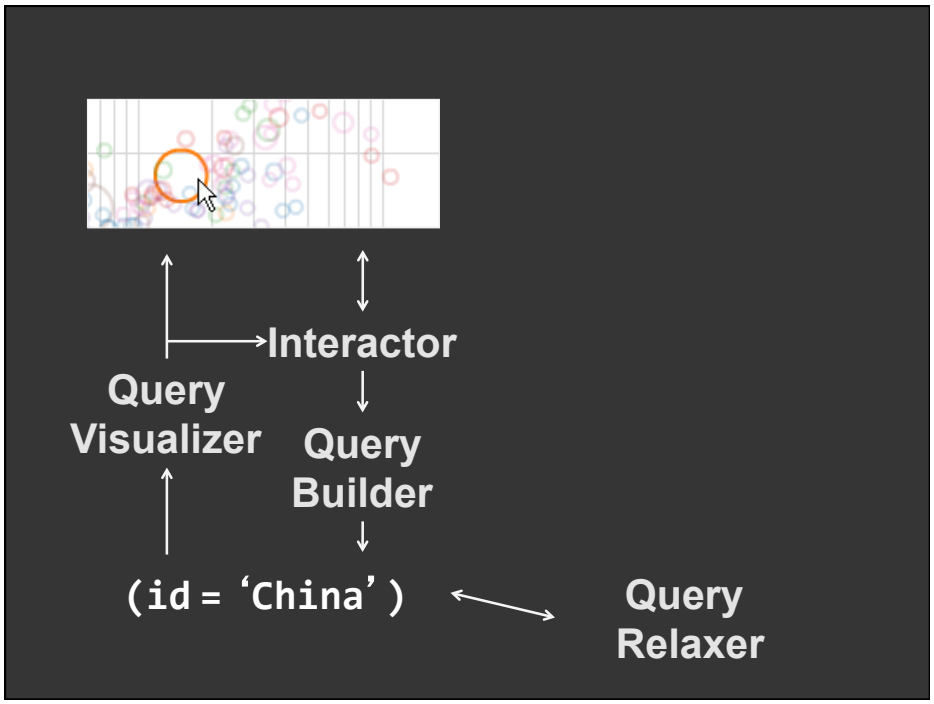


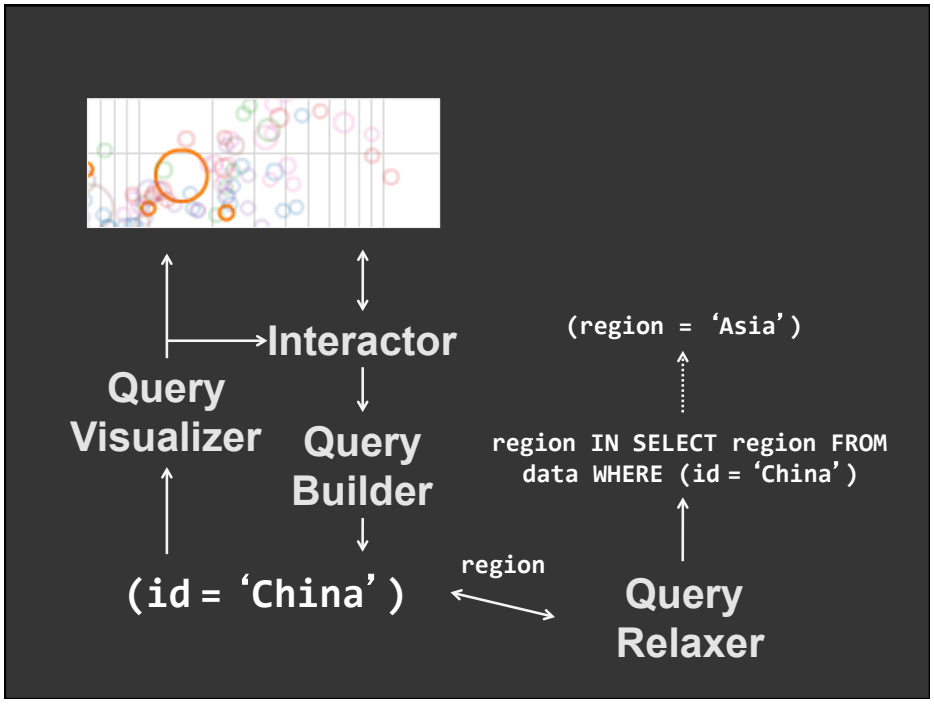
Legend: Select Attributes

(region = 'The Americas')




Interactor
Query Visualizer
Query Builder
(id = 'China')

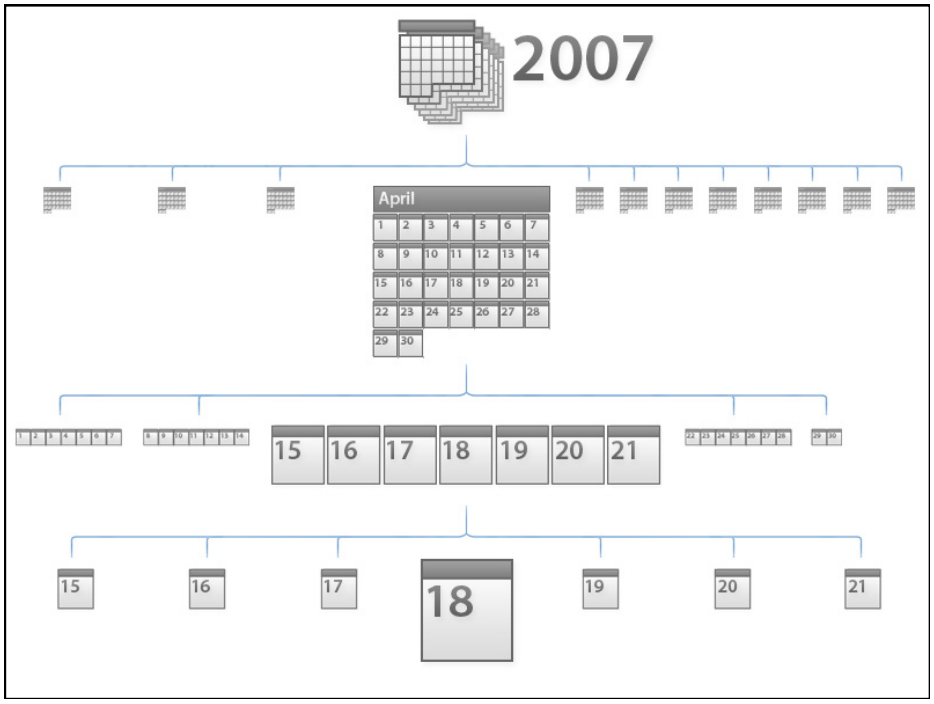

Interactor
Query Visualizer
Query Builder
(id = 'China')
Query Relaxer



Query Relaxation

Generalize an input query to create an expanded selection, according to:

1. A semantic structure describing the data
2. A traversal policy for that structure

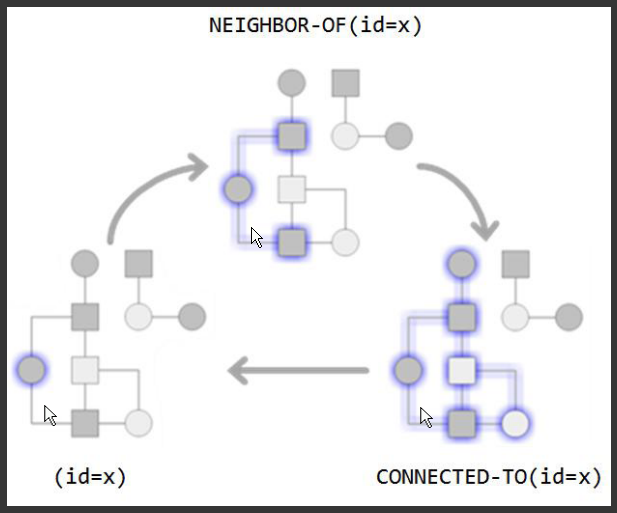


Relaxation using Hierarchies

Relax using abstraction hierarchies of the data
Traverse in direction of increasing generality

Examples
A Priori: Calendar, Categories, Geography
Data-Driven: Nearest-Neighbor, Clustering

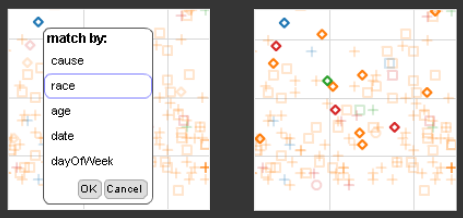
Relaxation of Networks



Relaxation using Attributes

If no explicit semantic structure is available, treat data itself as a "flat" hierarchy

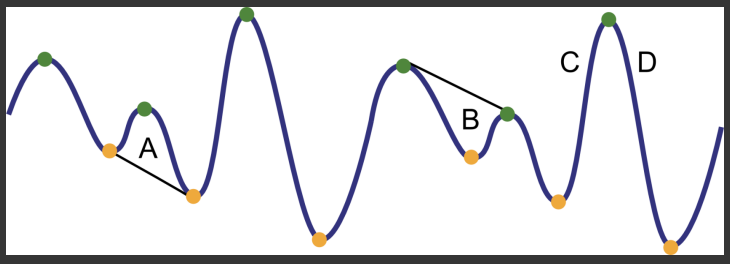
Select all items with matching values along the attributes chosen for relaxation



Lesson

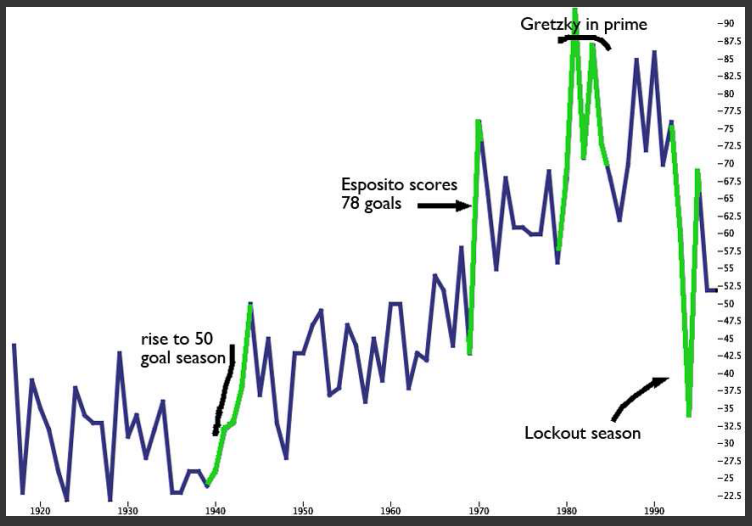
Consider how the structure and/or semantics of the data might be leveraged to aid analysis

Extension: look beyond data features to incorporate perceptual features of the display



Peaks, valleys, & slopes

Perceptual Annotation [Kong & Agrawala 09]



NHL Goals Per Year

Other Input Modalities

Multi-touch

- Tables, wall displays, tablets, whiteboards

- Does is facilitate visual analysis?
- What affordances are gained/lost?

Kinetica

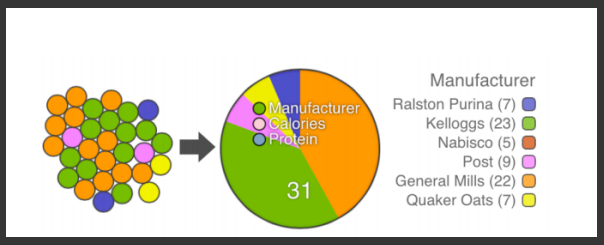
[Rzeszortarski and Kittur 2014]

Framework

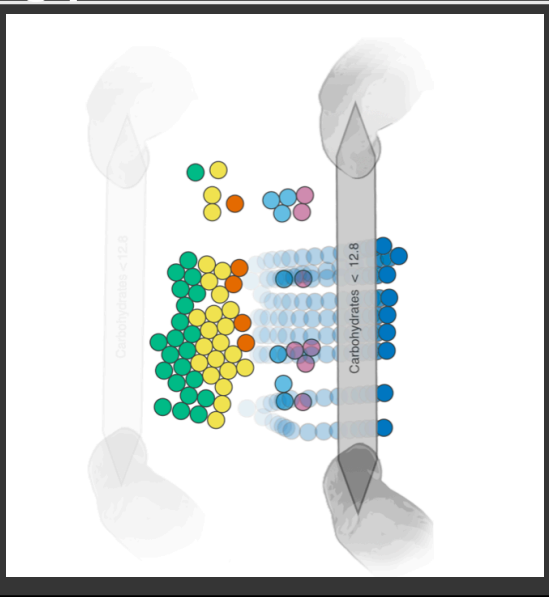
	Forces	Layouts	Mutations	Barriers	Filters	Queries & Overlays
Forces	***Magnets*** Points are pulled to a finger					
Layouts	***Force plots*** Points are pulled to their place in a chart	***Fixed charts*** Points snap to their place on a chart				
Mutations	***Group by vector*** Group points that are moving similarly	***Group by layout*** Group points by their place in a chart	***Groups*** Put points into abstract groups			
Barriers	***Jelly walls*** Points need an extra push to pass a wall	***Layout walls*** As points pass, put them into a layout	***Collision to data*** Points that hit a wall are assigned values	***Walls*** Block points from a region of space		
Filters	***Query magnet*** Attract points that meet specific criteria	***Detail view*** See point details in a layout popup	***Group by filter*** Group points based on specific criteria	***Sieves*** Walls only permit certain points	***Show/hide*** Display points by criteria	
Queries & Overlays	***Query fields*** Visualize the pull of different forces	***Area details*** See details for points that meet criteria	***Group zoom*** Zoom in and manipulate points	***Lens*** Highlight certain points in a region	***Selective overlay*** Highlight/select points by criteria	***Overlays*** Color/scale points by data dimensions

Forces - Act on points to move, attract, or accelerate
Layouts - Place points into meaningful locations
Mutations - Mutate, combine, or change points
Barriers - Prevent points from occupying a region
Filters - Selectively include or exclude based on criteria
Queries - Change the display appearance of points

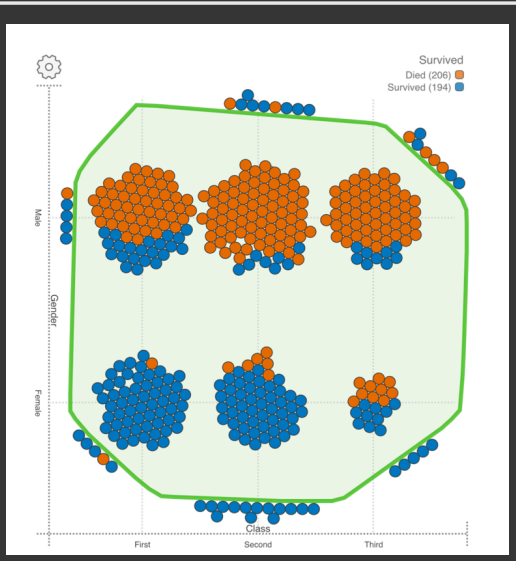
Grouping points



Filtering points



Filtering points



Summary

Most visualizations are interactive

- Even passive media elicit interactions

Good visualizations are task dependant

- Choose the right space
- Pick the right interaction technique

Human factors are important

- Leverage human strengths
- Assist to get past human limitations