

Interaction

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CS 448B: Visualization
Fall 2020

1

Stephen Curry's 3-Point Record in Context: Off the Charts

By GREGOR AISCH and KEVIN QUEALY APRIL 16, 2016

This chart contains 752 lines — one for each N.B.A. player who finished in the top 20 in 3-point attempts made in each season since 1980. [Skip this tip](#) is the Golden State Warrior Stephen Curry, who finished the regular season with a record 402 3-pointers.

The record is an outlier that defies most comparisons, but here is one: It is the equivalent of hitting 103 home runs in a Major League Baseball season.

The colors show a clear progression toward more 3-pointers. In the 1979-80 N.B.A. season, the first to feature the 3-pointer, [making just 21](#) was good enough to put a player among the league's top 20. On Feb. 27, Curry [made 19 3-pointers](#) in a single game.

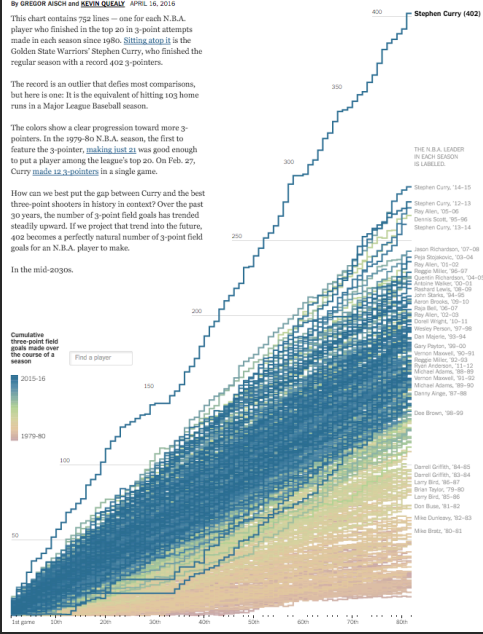
How can we best put the gap between Curry and the best three-point shooters in history in context? Over the past 30 years, the number of 3-point field goals has trended steadily upward. If we project that trend into the future, 402 becomes a perfectly natural number of 3-point field goals for an N.B.A. player to make.

In the mid-2000s,

Cumulative
three-point field
goals made over
the course of a
season

Find a player

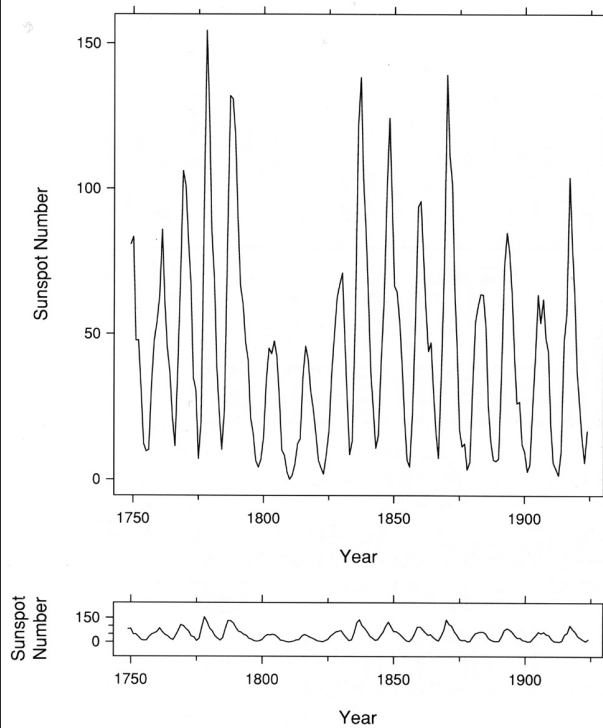
2015-16
1979-80



2

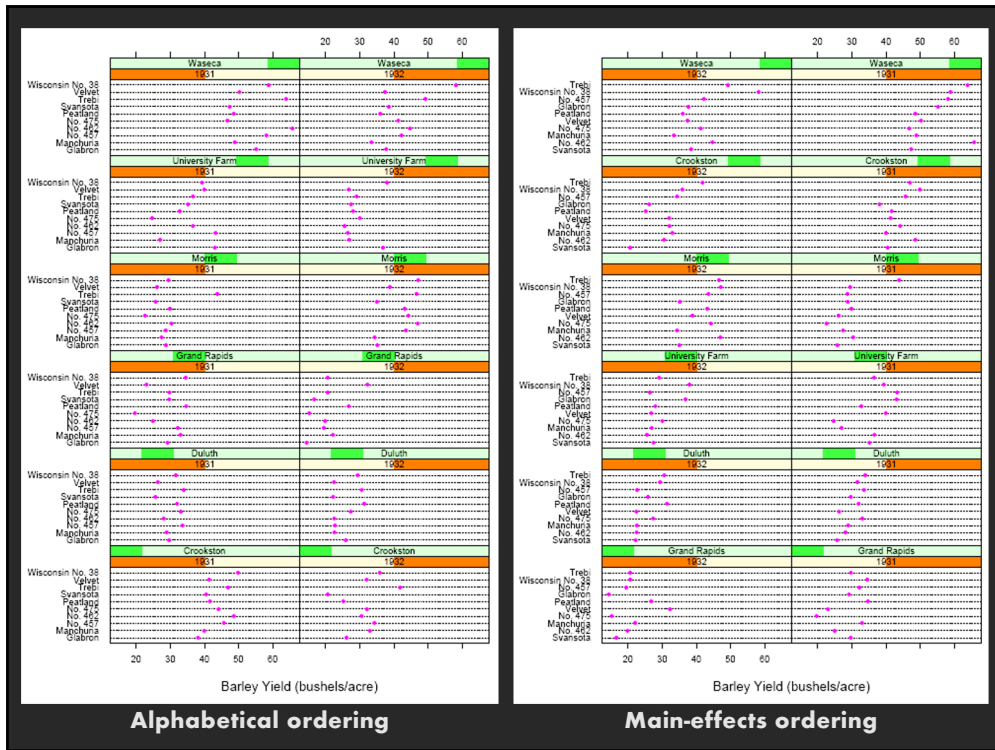
Last Time: Using Space Effectively

4



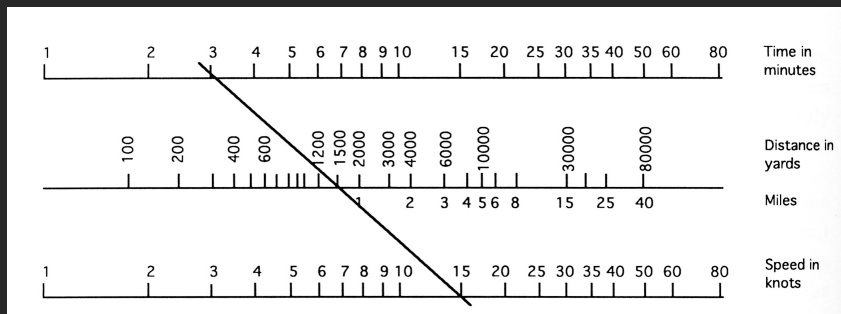
William S. Cleveland
*The Elements of
Graphing Data*

5



6

Nomograms



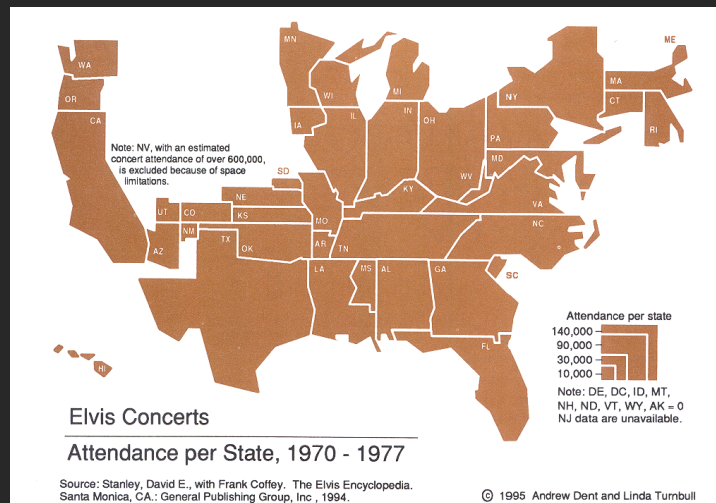
1. Compute in any direction; fix n-1 params and read nth param
2. Illustrate sensitivity to perturbation of inputs
3. Clearly show domain of validity of computation

7

Cartographic Distortion

8

Cartograms: Distort areas

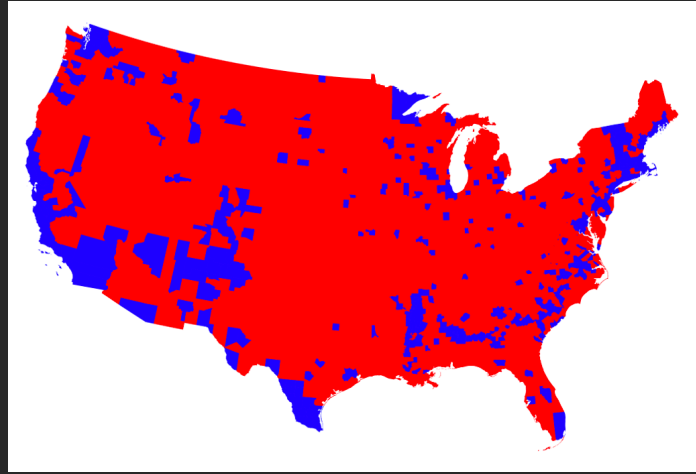


Scale area by data

[From *Cartography*, Dent]

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Election 2016 map

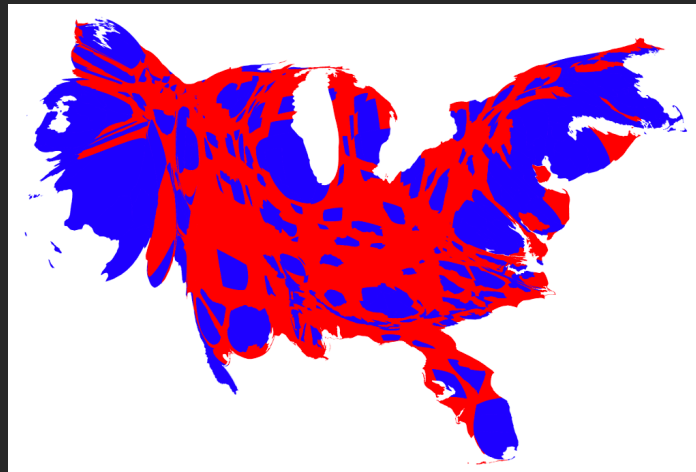


■ % voted democrat
■ % voted republican

<http://www-personal.umich.edu/~mejn/election/>

10

Election 2016 map

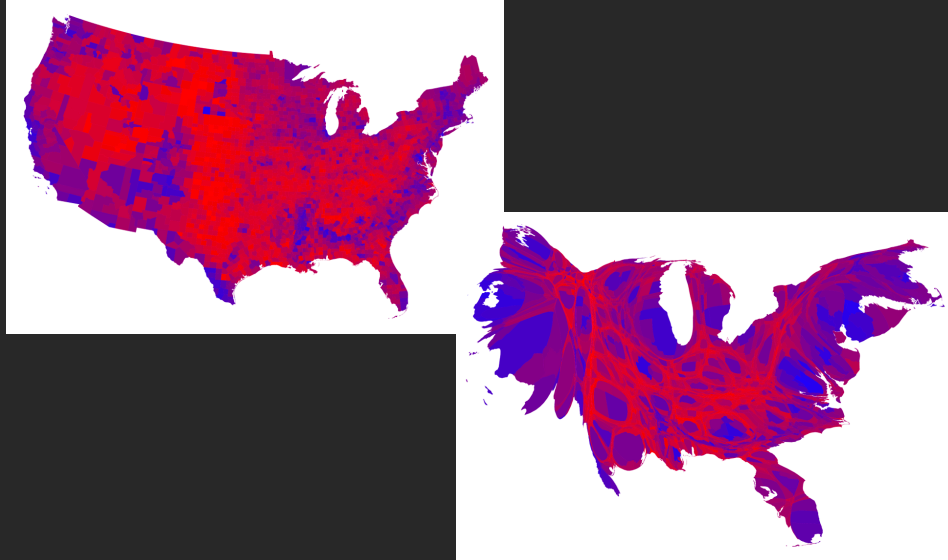


■ % voted democrat
■ % voted republican

<http://www-personal.umich.edu/~mejn/election/>

11

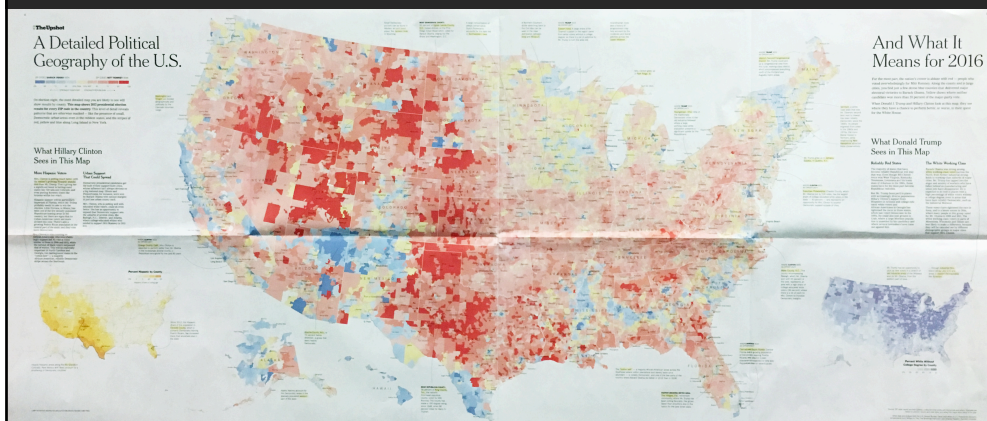
Election 2016 map



<http://www-personal.umich.edu/~mejn/election/>

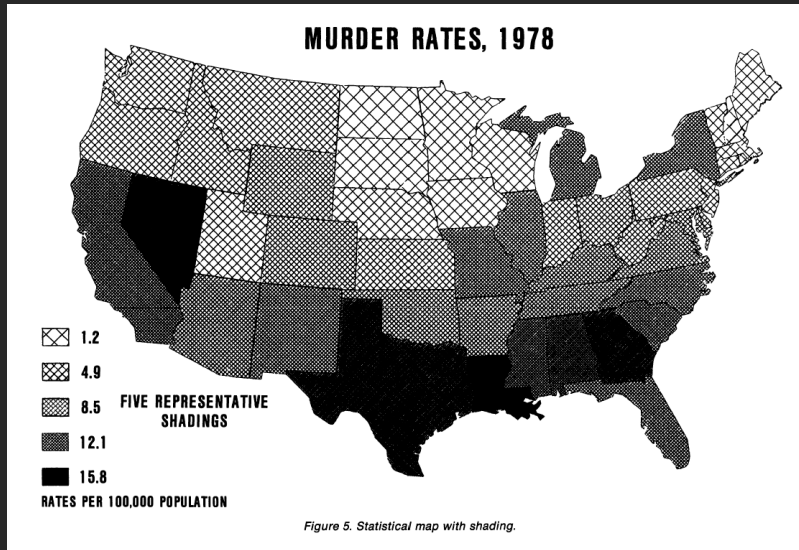
12

NYT Election 2016 (based on 2012)



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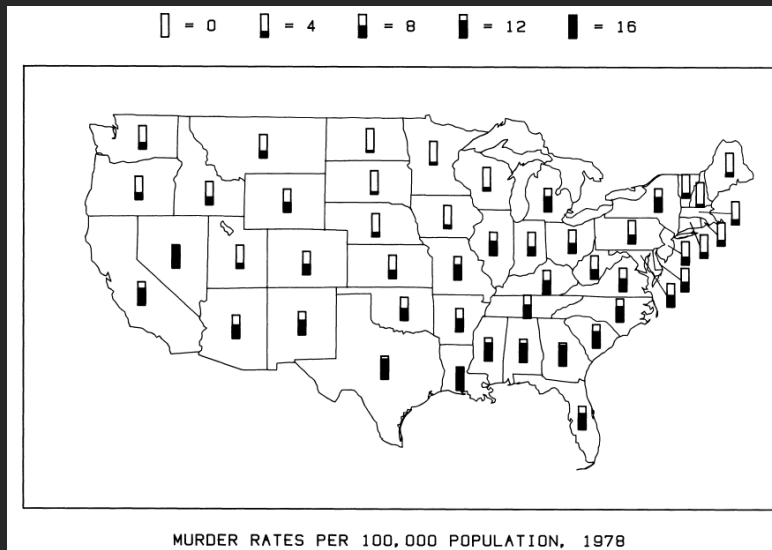
Statistical map with shading



[Cleveland and McGill 84]

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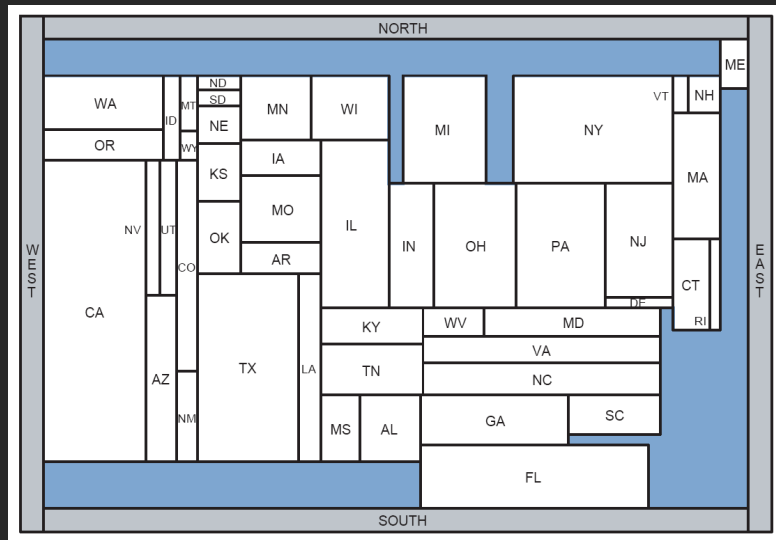
Framed rectangle chart



[Cleveland and McGill 84]

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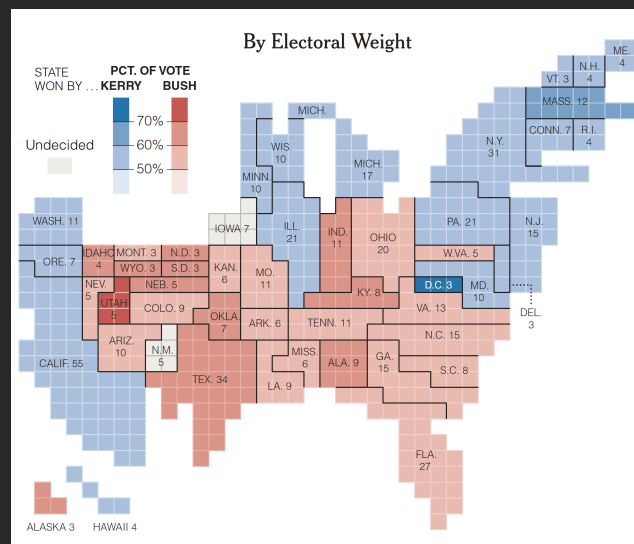
Rectangular cartogram



American population [van Kreveld and Speckmann 04]

16

New York Times Election 2004



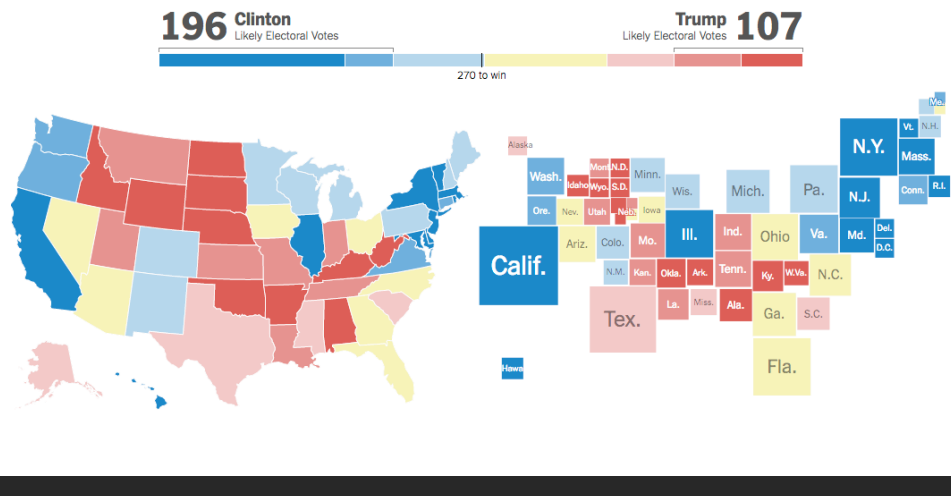
18

New York Times Election 2016

2016 Electoral Map Forecast

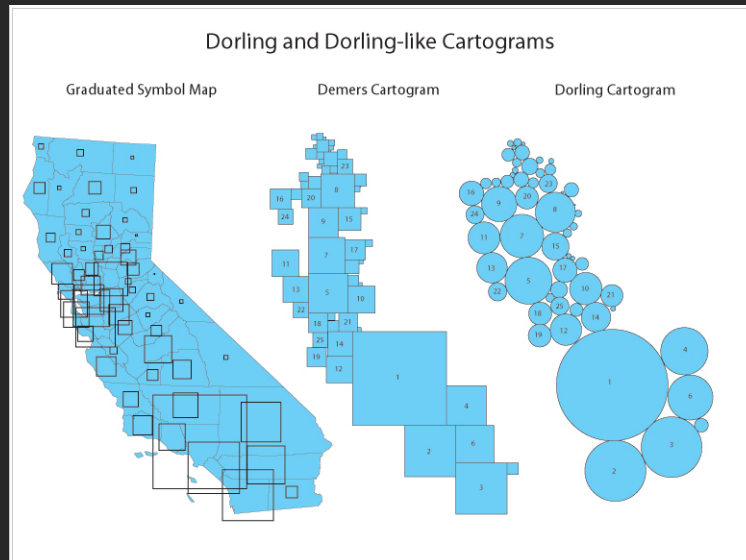
The Upshot's forecast for the presidential race, based on the latest national and state polls.

By JOSH KATZ and ADAM PEARCE UPDATED November 2, 2016



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Dorling cartogram

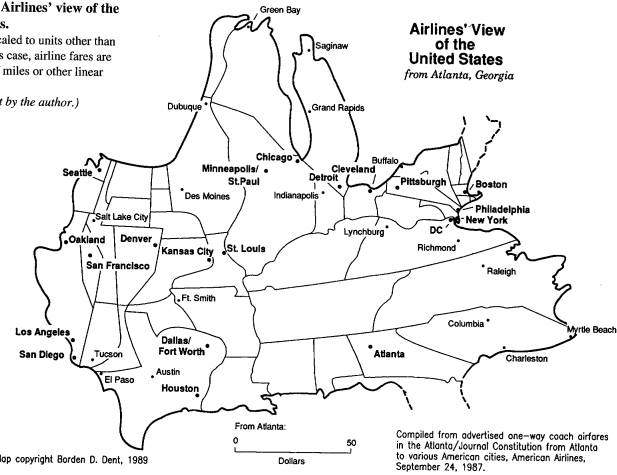


http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html

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Distorting distances

Figure 1.8 Airlines' view of the United States.
 Maps can be scaled to units other than distance. In this case, airline fares are used instead of miles or other linear units.
 (Map copyright by the author.)



Scale distance by data (airline fare)
 [From Cartography, Dent]

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London underground



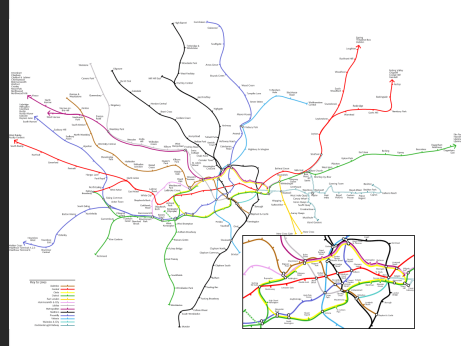
<http://www.thetube.com/content/history/map.asp>

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Comparison to geographic map



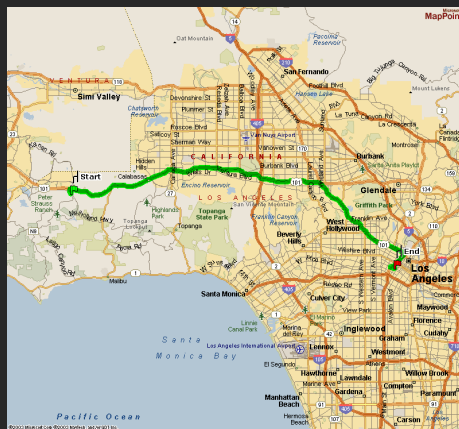
Distorted



Undistorted

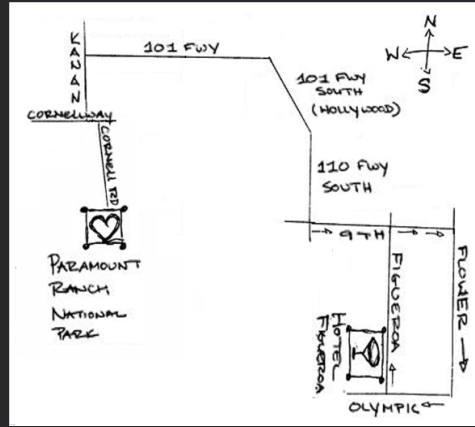
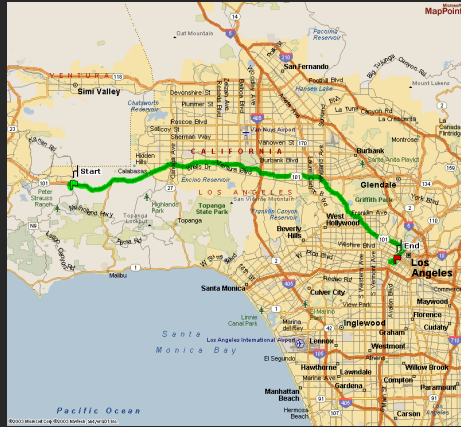
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Visualizing Routes



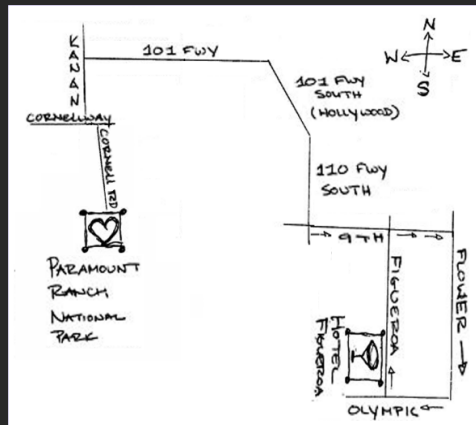
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A Better Visualization

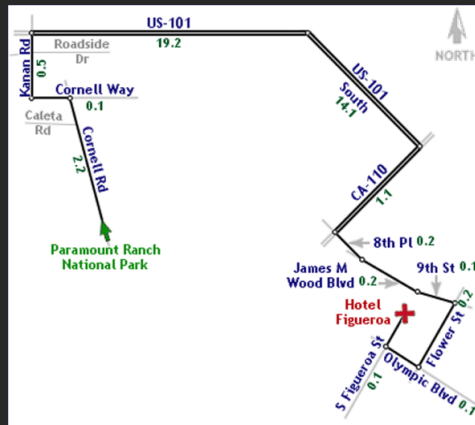


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LineDrive [Agrawala & Stolte 2001]



Hand-drawn route map



LineDrive route map

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Summary

- Space is the most important visual encoding
- Show data with as much resolution as possible
- Geometric properties of spatial transforms support geometric reasoning
- Use distortions to emphasize important information

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Announcements

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A2: Exploratory Data Analysis

Use **Tableau** to formulate & answer questions

First steps

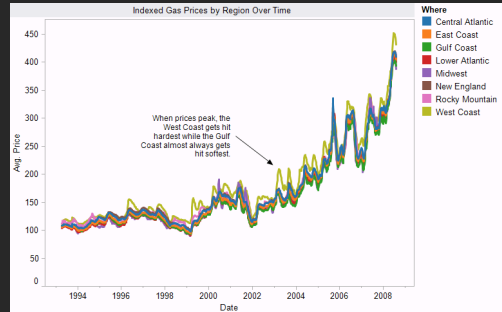
- Step 1: Pick domain & data
- Step 2: Pose questions
- Step 3: Profile data
- Iterate as needed

Create visualizations

- Interact with data
- Refine questions

Author a report

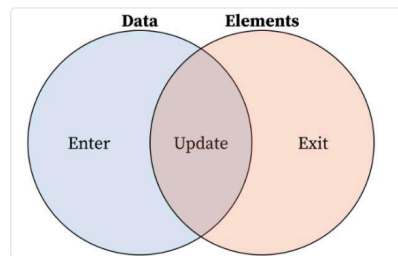
- Screenshots of most insightful views (10+)
- Include titles and captions for each view



Due before class on Oct 6, 2020

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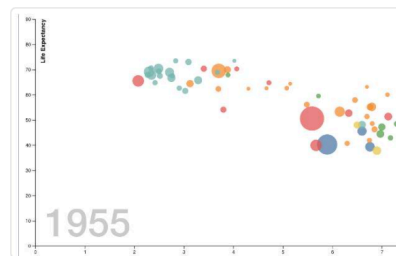
D3 Notebooks for Next Week



Team Published

Introduction to D3

You republished 14 hours ago



You Published

Making D3 Charts Interactive

You republished 14 hours ago

31

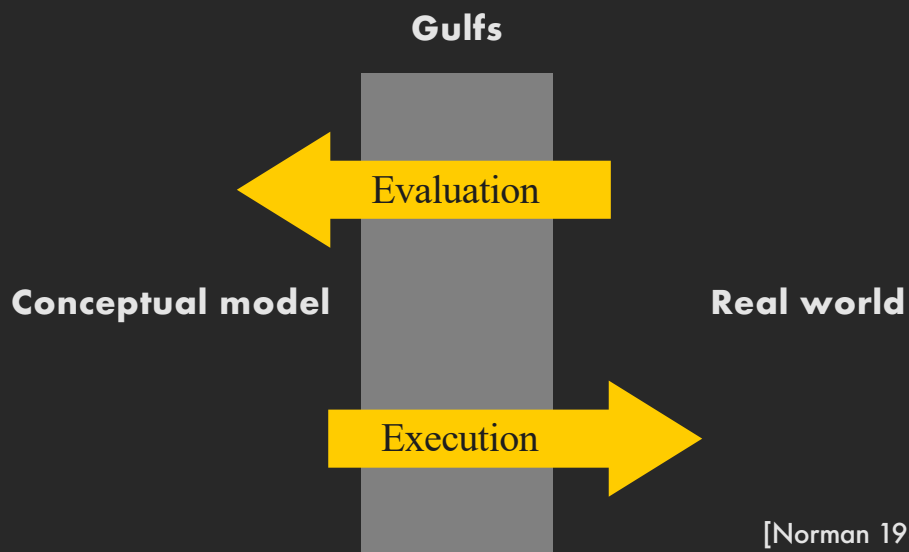
Interaction

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Interaction between people and machines requires *mutual intelligibility* or *shared understanding*

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Gulfs of execution & evaluation



[Norman 1986]

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Gulf of Execution

The difference between the user's intentions and the allowable actions.

Gulf of Evaluation

The amount of effort that the person must exert to interpret the state of the system and to determine how well the expectations and intentions have been met.

[Norman 1986]

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Gulf of evaluation

Gulf



Conceptual model:
 x, y correlated?

Real world:

X	Y
0.67	0.79
0.32	0.63
0.39	0.72
0.27	0.85
0.71	0.43
0.63	0.09
0.03	0.03
0.20	0.54
0.51	0.38
0.11	0.33
0.46	0.46

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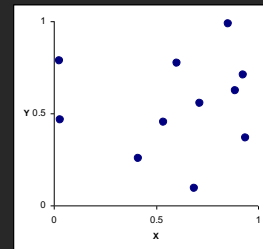
Gulf of evaluation

Gulf



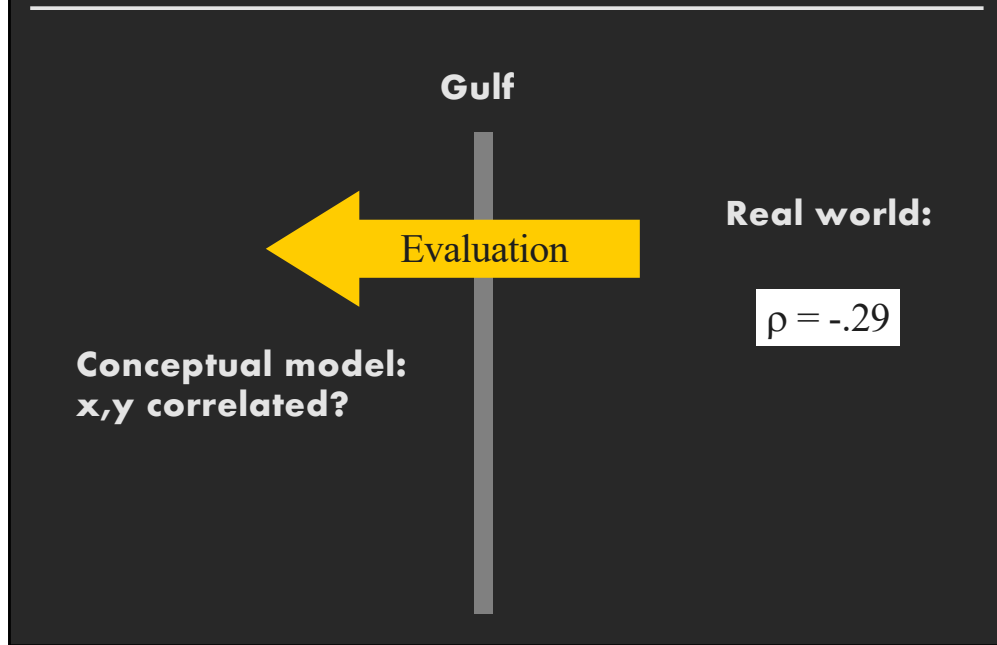
Conceptual model:
 x, y correlated?

Real world:



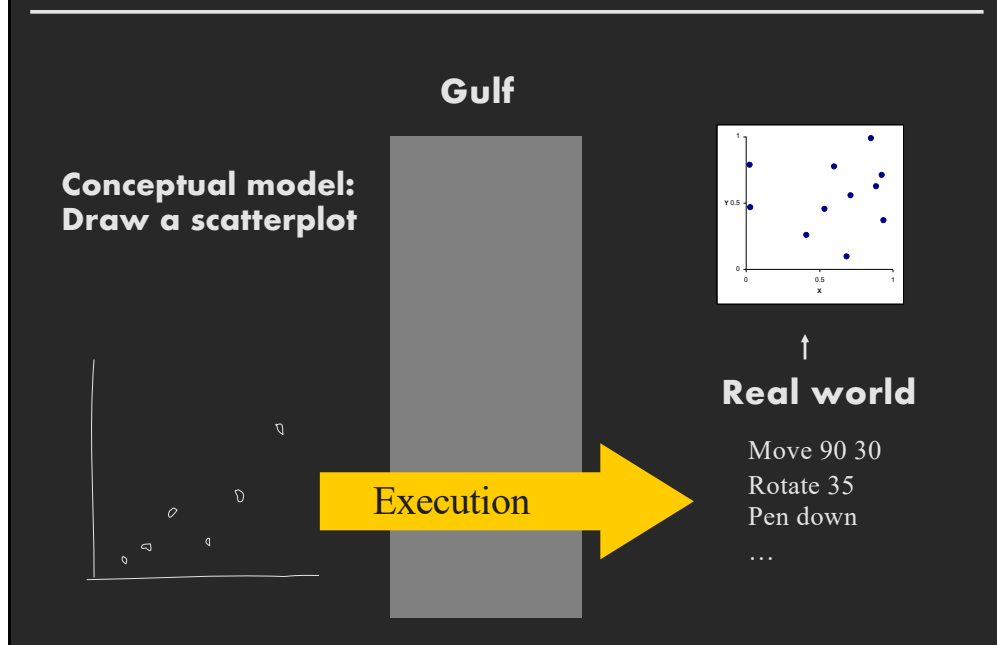
37

Gulf of evaluation



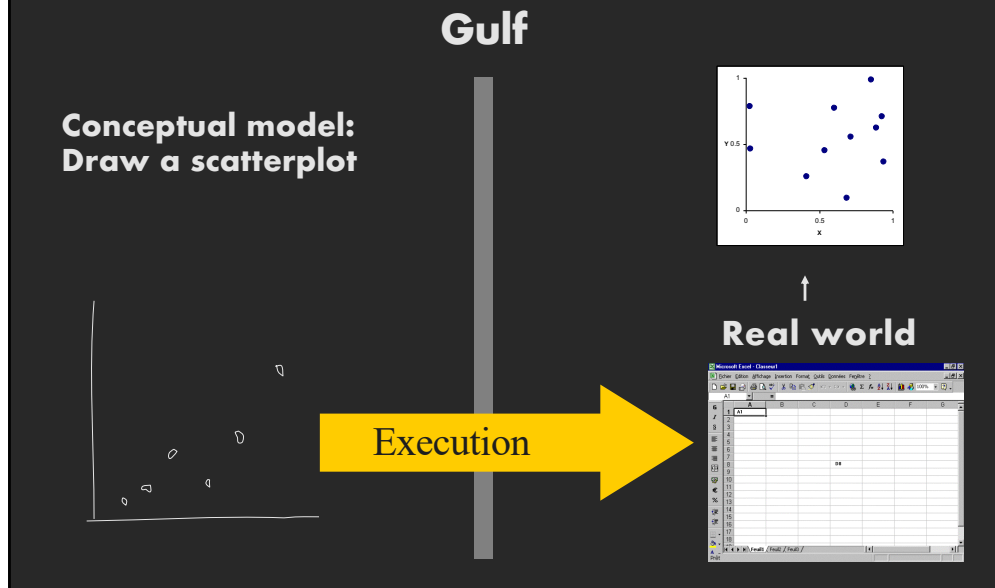
38

Gulf of execution



39

Gulf of execution



40

Gulf of Execution

The difference between the user's intentions and the allowable actions.

Gulf of Evaluation

The amount of effort that the person must exert to interpret the state of the system and to determine how well the expectations and intentions have been met.

[Norman 1986]

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Topics

Early interactive systems

Brushing and linking

Dynamic queries

Generalized selections

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Early Systems

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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	57	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]

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Bertin Matrices

Research question

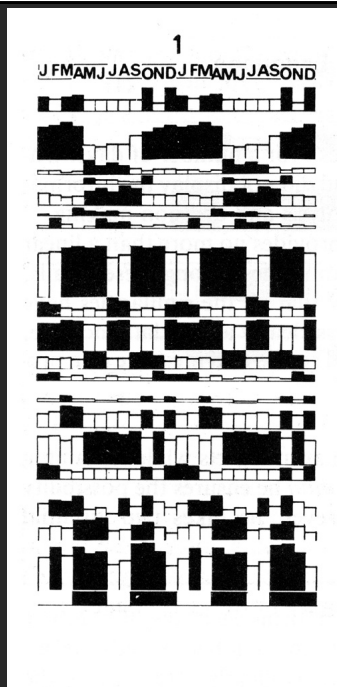


Table



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

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[Graphics and Graphic Information Processing, Bertin 81]

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Group similar rows and columns

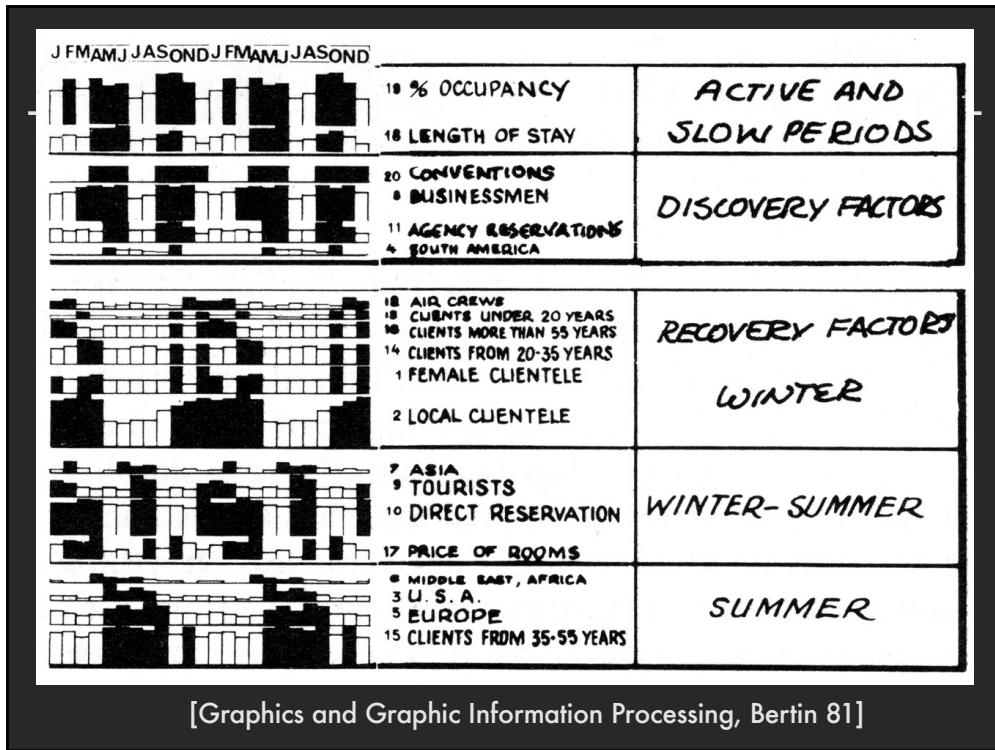
Choose a row with a particular visual aspect. Move to extremity of matrix

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

Repeat for columns (only in some cases)

Iterate

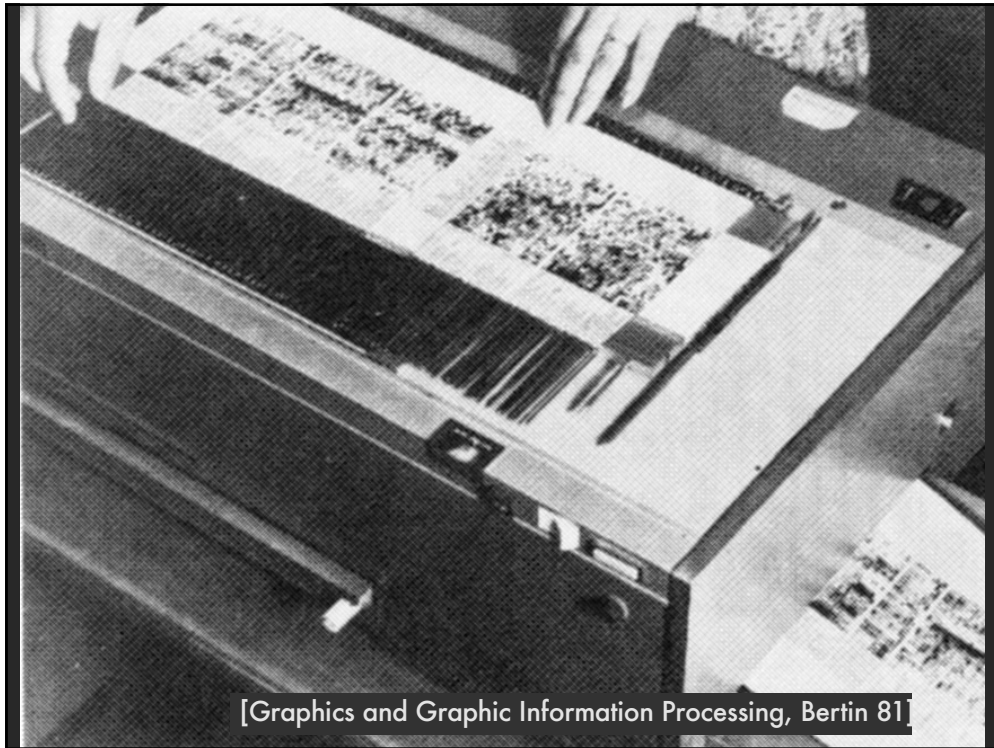
47



48



49



50



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	Bel	Cze	Den	Fin	Fra	Ger	Gre	Ita	Nor	Pol	Por	Rus	Spa	Swe	Uni
Household in	26	61	69	24	62	57	28	72	20	42	31	41	53	19	31
Women's suf	19	41	92	19	19	0	94	19	19	5	19	19	19	19	19
Against coha	12	42	4	18	8	20	30	46	12	39	17	39	16	6	19
Belief in God	61	36	63	69	52	63	93	91	56	96	86	77	76	46	65
Confidence	32	21	55	42	34	29	22	28	51	23	30	60	35	54	19
Confidence	50	34	72	83	73	58	70	75	57	63	75	73	57	41	89
Confidence	36	20	63	47	41	40	52	67	44	65	67	67	31	39	36
Confidence	91	42	75	73	78	34	39	54	74	44	58	51	79	75	80
Confidence	50	35	87	73	56	58	50	36	78	44	48	41	42	69	51
Important in	60	85	54	58	58	73	94	76	56	93	88	93	77	52	75
Against abo	56	51	28	40	44	60	65	72	42	75	61	63	57	25	57
Not as a nei	7	22	5	12	5	16	30	21	6	52	21	61	5	7	10
Attend churc	15	13	5	7	11	12	19	35	9	54	25	8	21	9	17

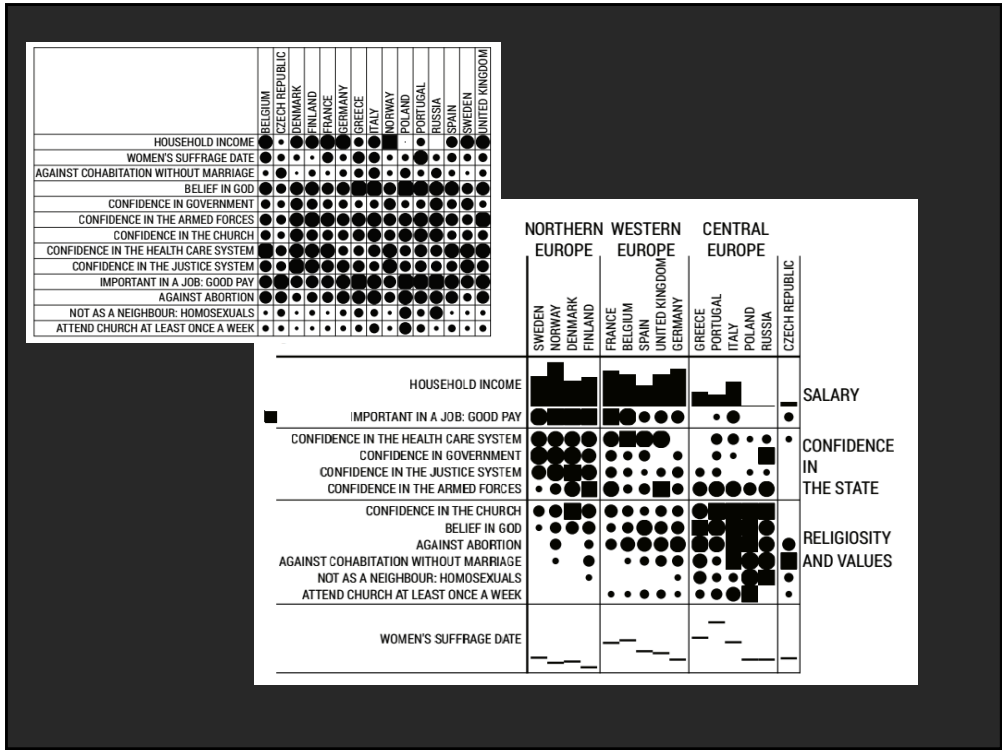
Bertifier [Perin 2014]

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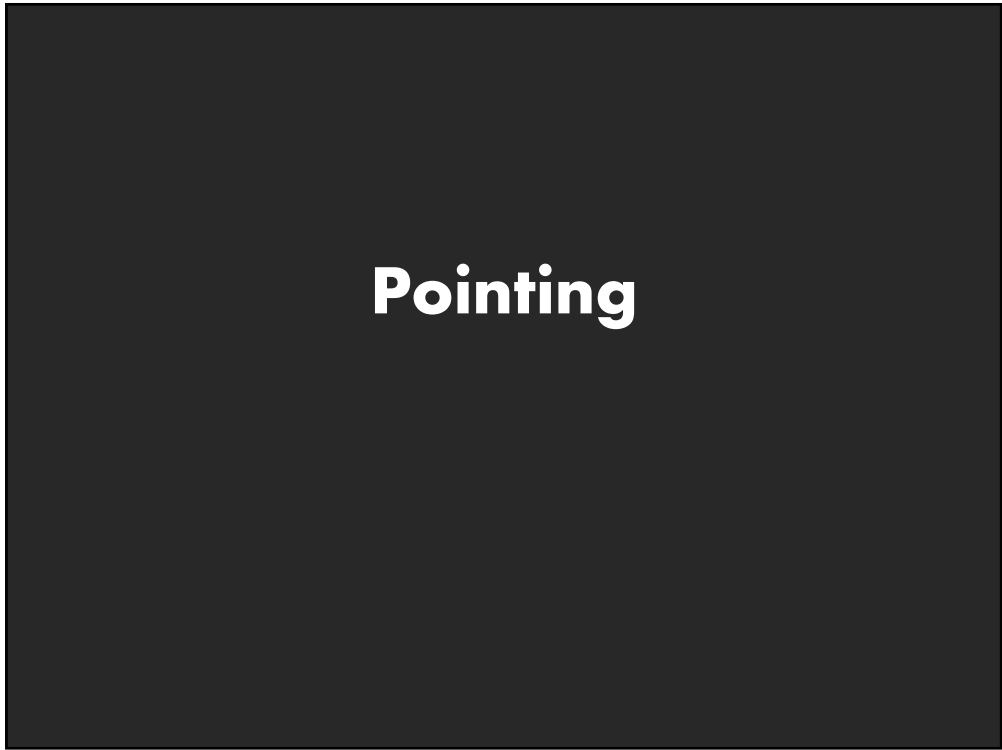
	BELGIUM	CZECH REPUBLIC	DENMARK	FINLAND	FRANCE	GERMANY	GREECE	ITALY	NORWAY	POLAND	PORTUGAL	RUSSIA	SPAIN	SWEDEN	UNITED KINGDOM
HOUSEHOLD INCOME	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
WOMEN'S SUFFRAGE DATE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AGAINST COHABITATION WITHOUT MARRIAGE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
BELIEF IN GOD	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CONFIDENCE IN GOVERNMENT	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CONFIDENCE IN THE ARMED FORCES	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CONFIDENCE IN THE CHURCH	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CONFIDENCE IN THE HEALTH CARE SYSTEM	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CONFIDENCE IN THE JUSTICE SYSTEM	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IMPORTANT IN A JOB: GOOD PAY	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AGAINST ABORTION	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
NOT AS A NEIGHBOUR: HOMOSEXUALS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ATTEND CHURCH AT LEAST ONCE A WEEK	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Bertifier [Perin 2014]

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Basic Pointing Methods

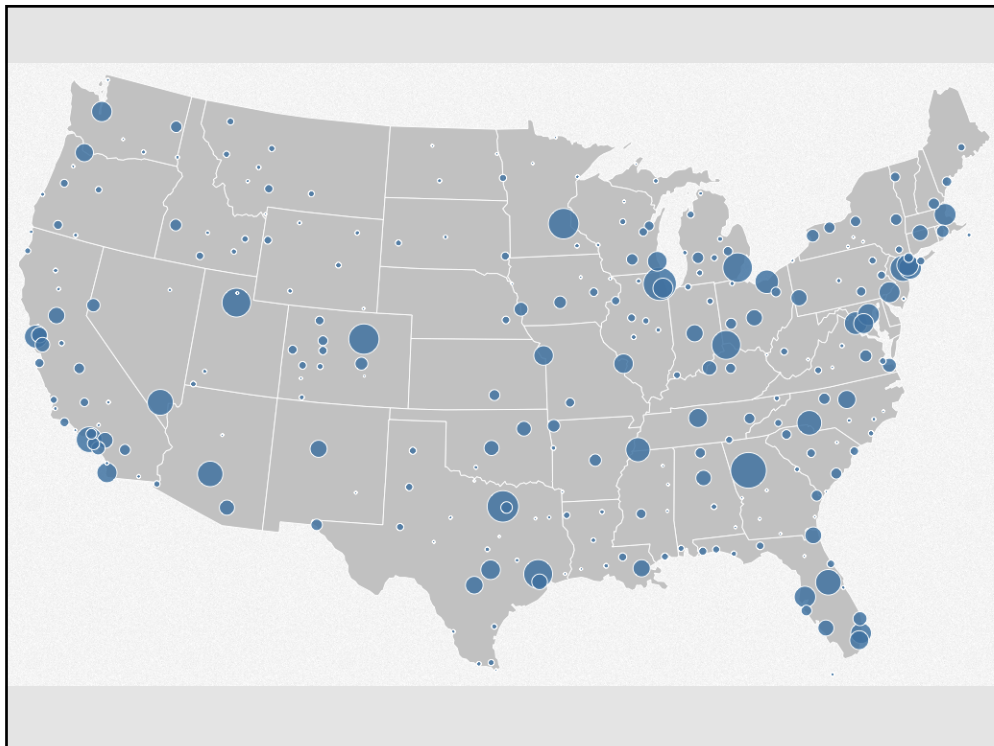
Point Selection

Mouse Hover / Click

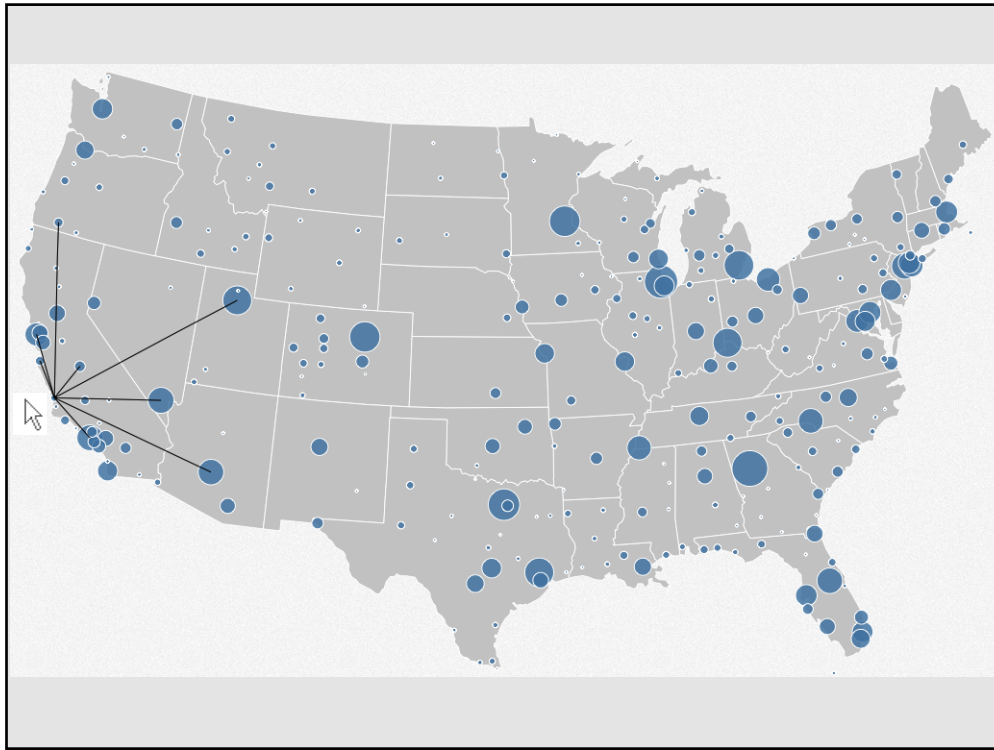
Touch / Tap

Select Nearby Element (e.g., Bubble Cursor)

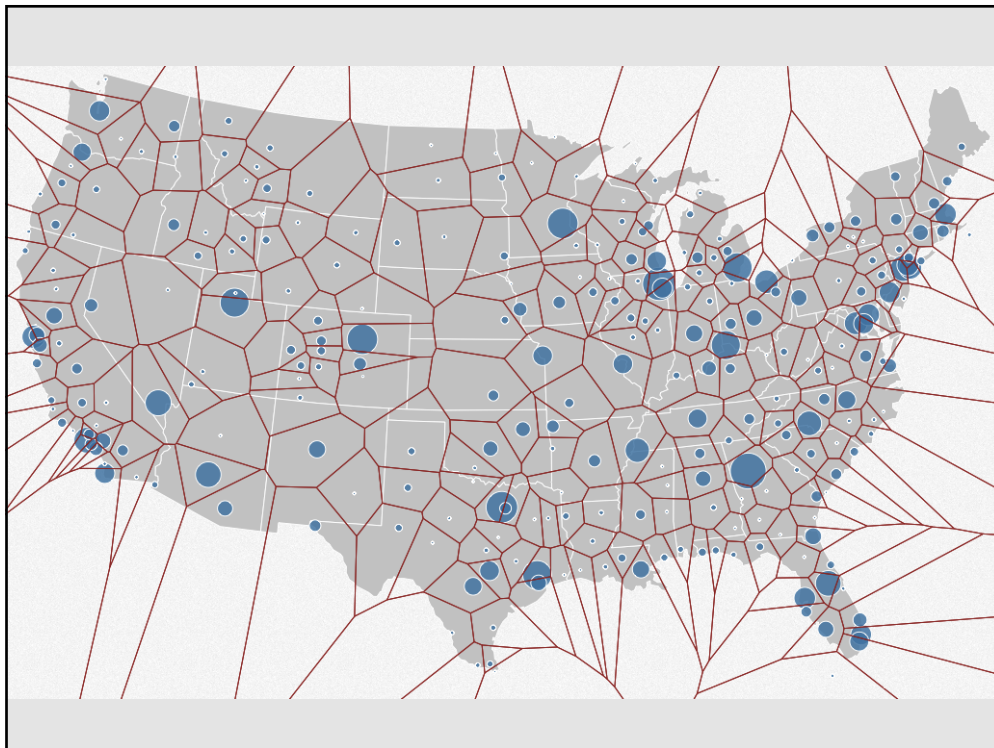
61



62



63



64

Basic Pointing Methods

Point Selection

Mouse Hover / Click

Touch / Tap

Select Nearby Element (e.g., Bubble Cursor)

Region Selection

Rubber-band or Lasso

Area Cursors ("Brushes")

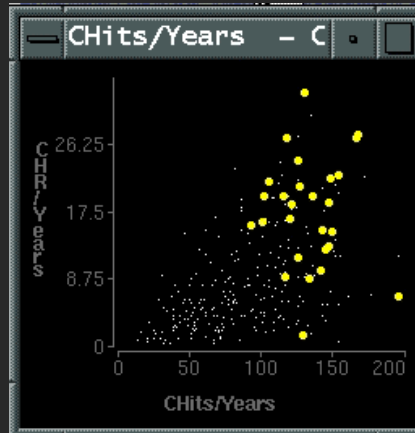
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Brushing and Linking

66

Highlighting

Focus user attention on a subset of the data within one graph [from Wills 95]



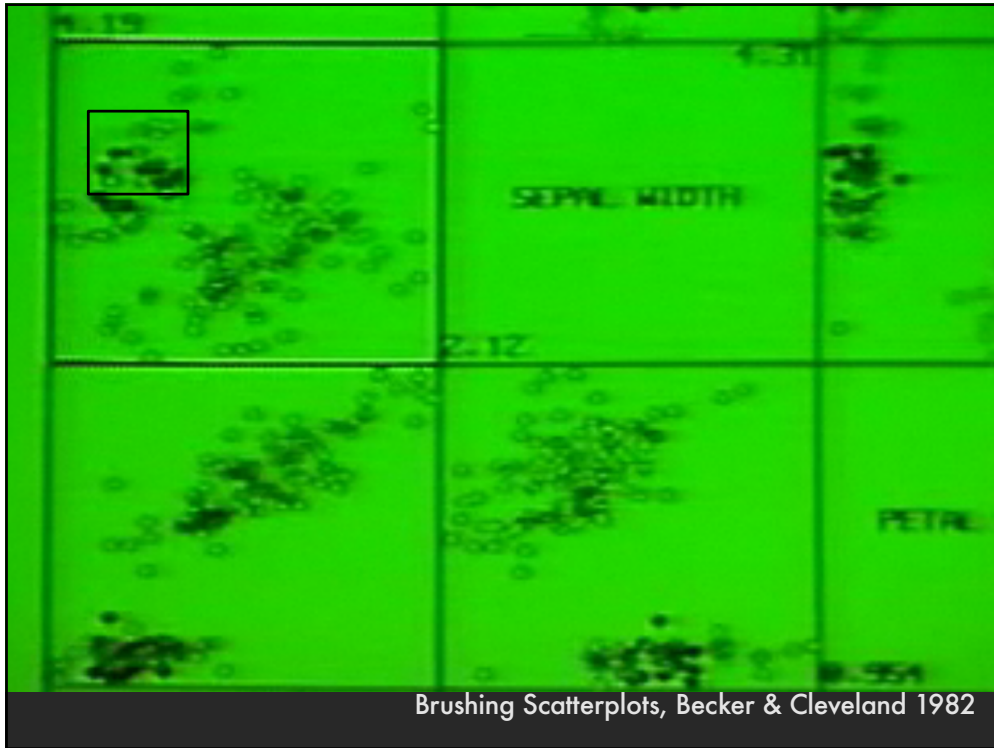
67

Brushing and Linking

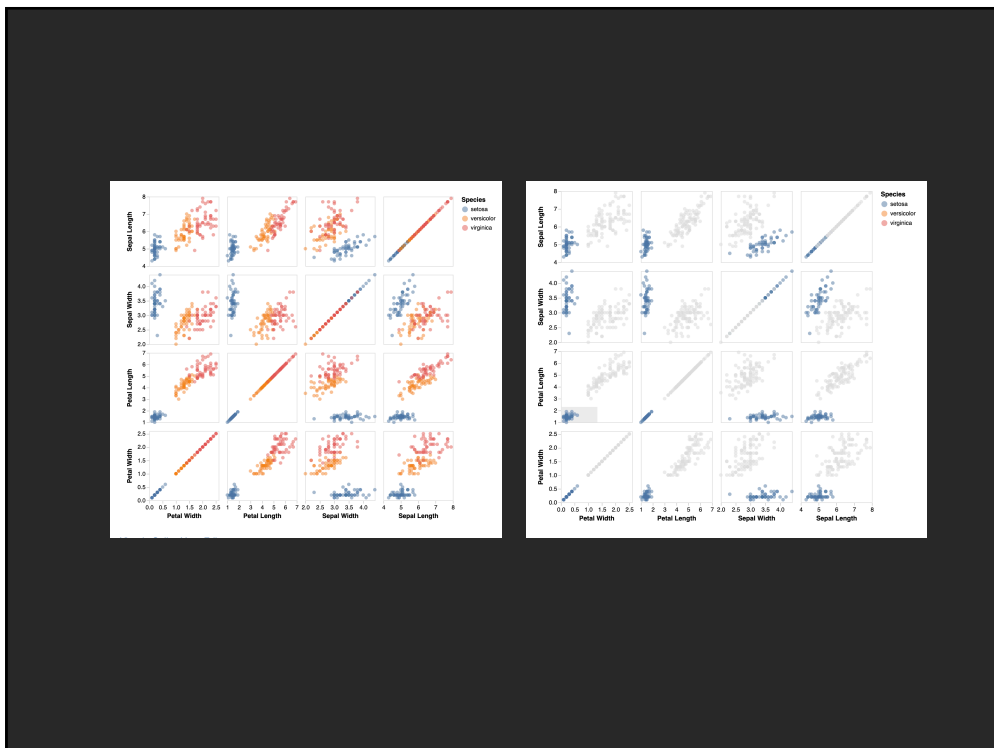
Select ("*brush*") a subset of data
See selected data in other views

The views must be *linked*
by *tuple* (matching data points), or
by *query* (matching range or values)

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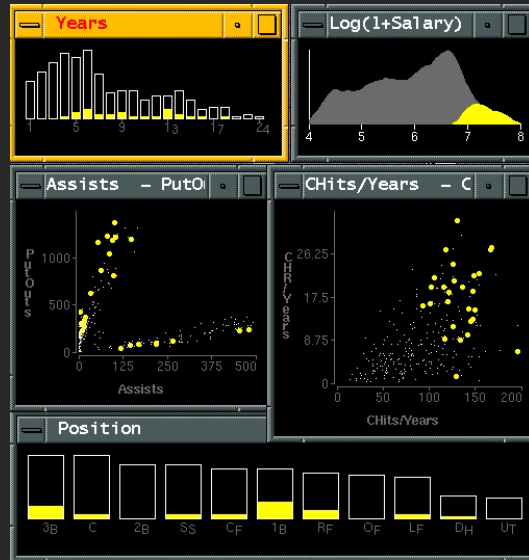


69



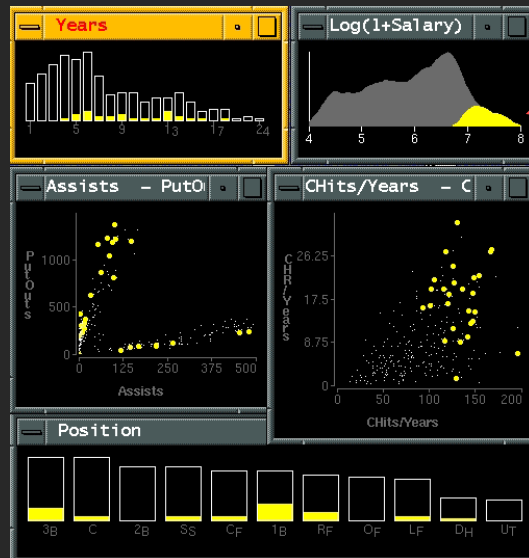
70

Baseball statistics [from Wills 95]



71

Baseball statistics [from Wills 95]



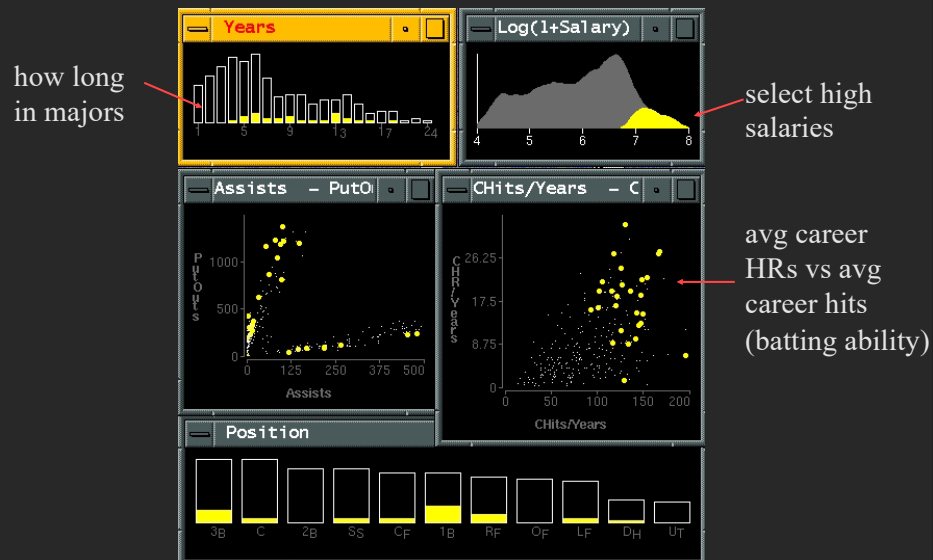
72

Baseball statistics [from Wills 95]



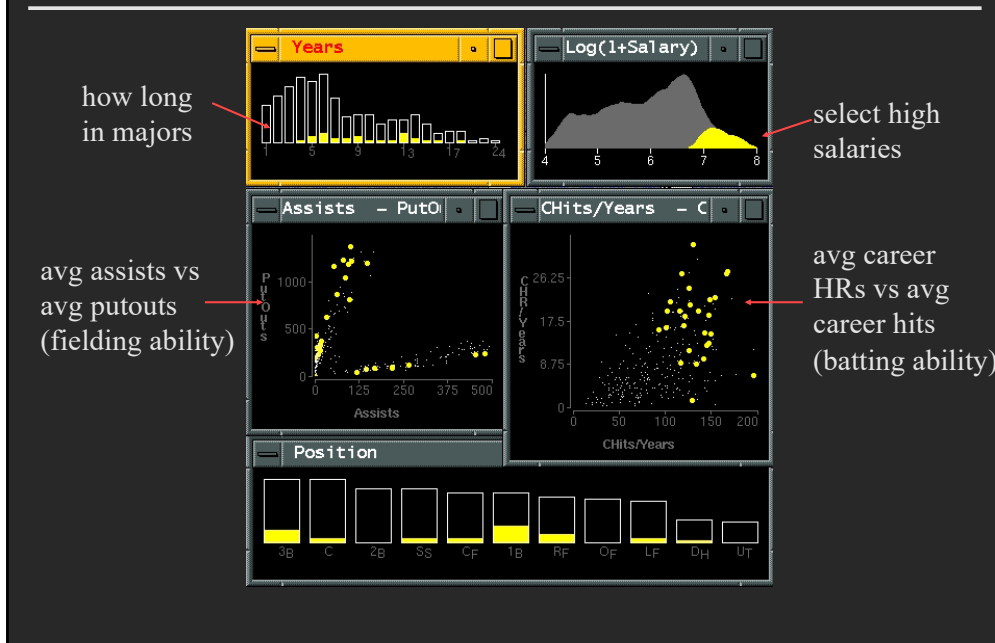
73

Baseball statistics [from Wills 95]



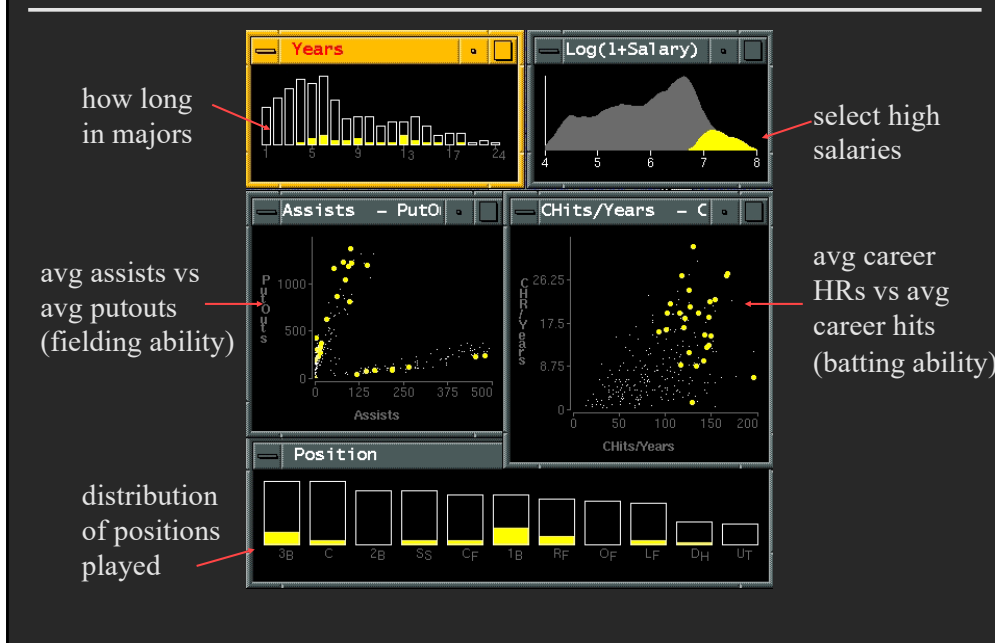
74

Baseball statistics [from Wills 95]



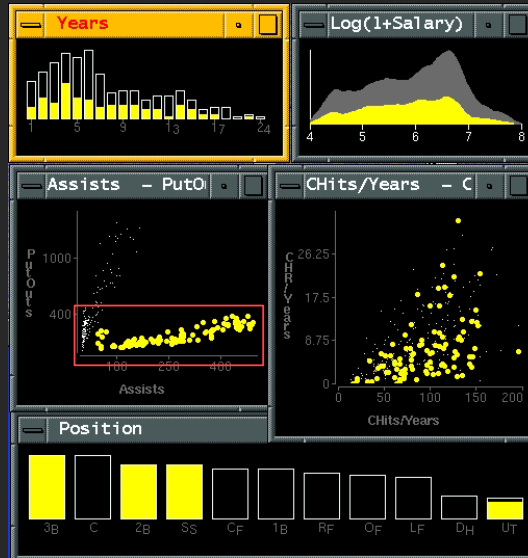
75

Baseball statistics [from Wills 95]



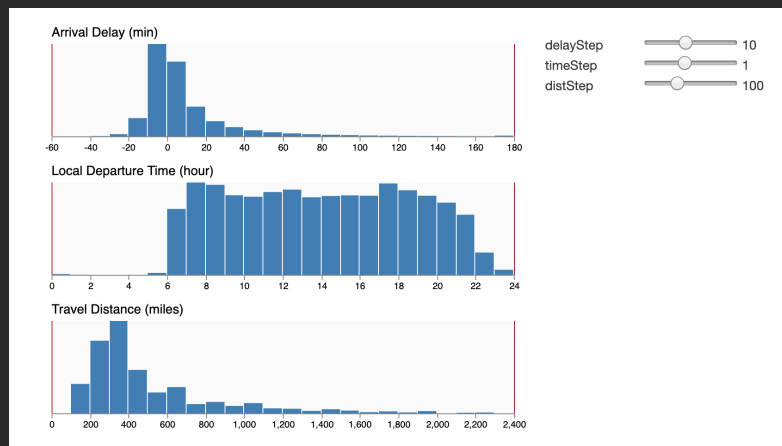
76

Linking assists to positions



77

CrossFiltering



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Dynamic Queries

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Query and results

```
SELECT house
FROM east bay
WHERE price < 1,000,000 AND bedrooms > 2
ORDER BY price
```

IdNumber	Dwelling	Address	City
2	House	5256 S. Capitol St.	Beltsville, MD
4	House	5536 S. Lincoln St.	Beltsville, MD
5	House	5165 Jones Street	Beltsville, MD
8	House	5007 Jones Street	Beltsville, MD
9	House	4872 Jones Street	Beltsville, MD
17	House	5408 S. Capitol St.	Beltsville, MD
20	House	5496 S. Capitol St.	Beltsville, MD
85	Condo	5459 S. Lincoln St.	Laurel, MD
86	Condo	5051 S. Lincoln St.	Laurel, MD
88	Condo	5159 Hamilton Street	Laurel, MD
92	Condo	5132 Hamilton Street	Laurel, MD
93	Condo	5221 S. Lincoln St.	Laurel, MD
94	Condo	5043 S. Lincoln St.	Laurel, MD
95	Condo	4970 Jones Street	Laurel, MD
97	Condo	4677 Jones Street	Laurel, MD
98	Condo	4896 S. Capitol St.	Laurel, MD
99	Condo	5048 S. Capitol St.	Laurel, MD
100	Condo	4597 31st Street	Laurel, MD
101	Condo	5306 S. Lincoln St.	Laurel, MD
103	Condo	5562 Glass Road	Laurel, MD
105	Condo	5546 Hamilton Street	Laurel, MD
152	House	7670 31st Street	Upper Marlboro, MD

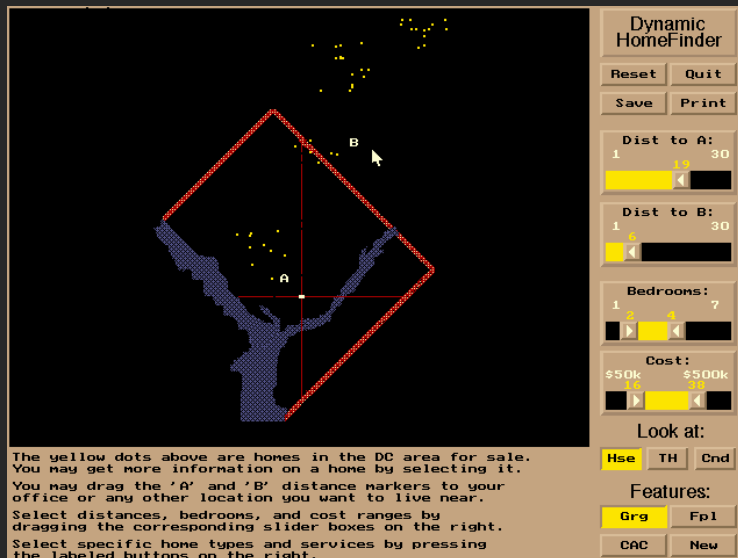
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Issues

1. For programmers
2. Rigid syntax
3. Only shows exact matches
4. Too few or too many hits
5. No hint on how to reformulate the query
6. Slow question-answer loop
7. Results returned as table

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HomeFinder



The yellow dots above are homes in the DC area for sale. You may get more information on a home by selecting it. You may drag the 'A' and 'B' distance markers to your office or any other location you want to live near. Select distances, bedrooms, and cost ranges by dragging the corresponding slider boxes on the right. Select specific home types and services by pressing the labeled buttons on the right.

[Ahlberg and Schneiderman 92]

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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**