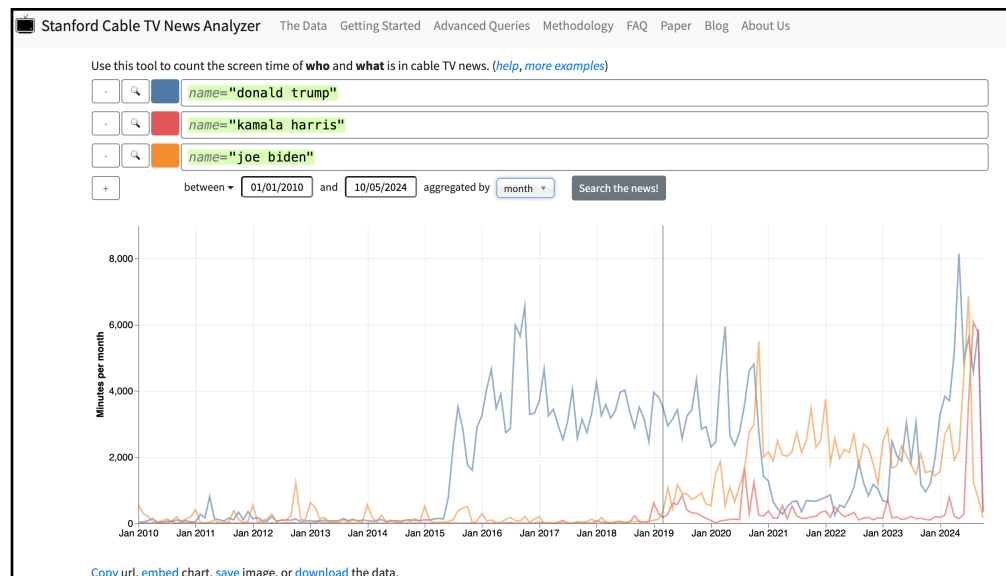


# INTERACTION

CS 448B | Fall 2024

MANEESH AGRAWALA

1



2

# TODAY

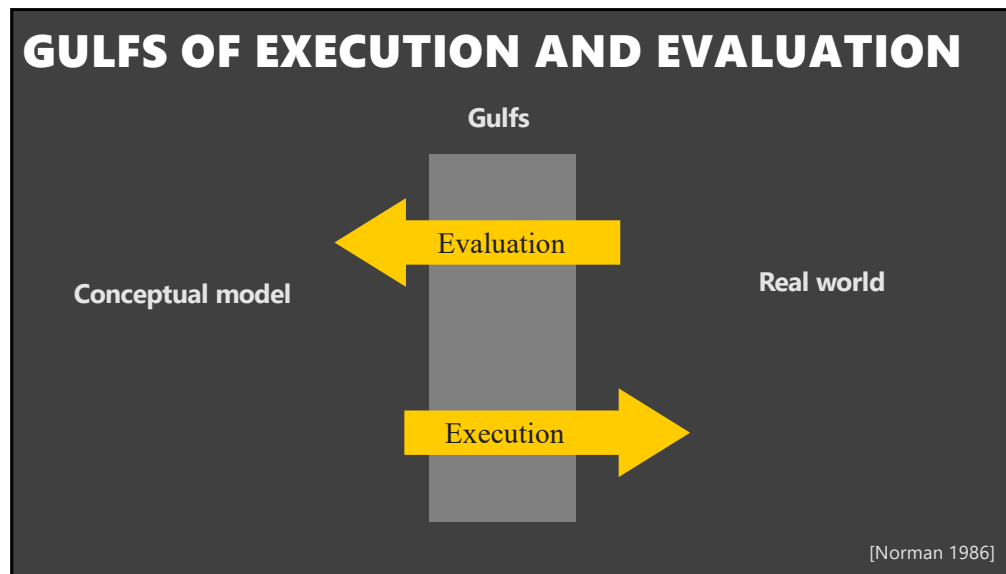
## Learning Objectives

1. Conceptual models, system models and the gulfs of execution and evaluation
2. Common interaction techniques: Selection, Brushing and Linking and Dynamic Queries

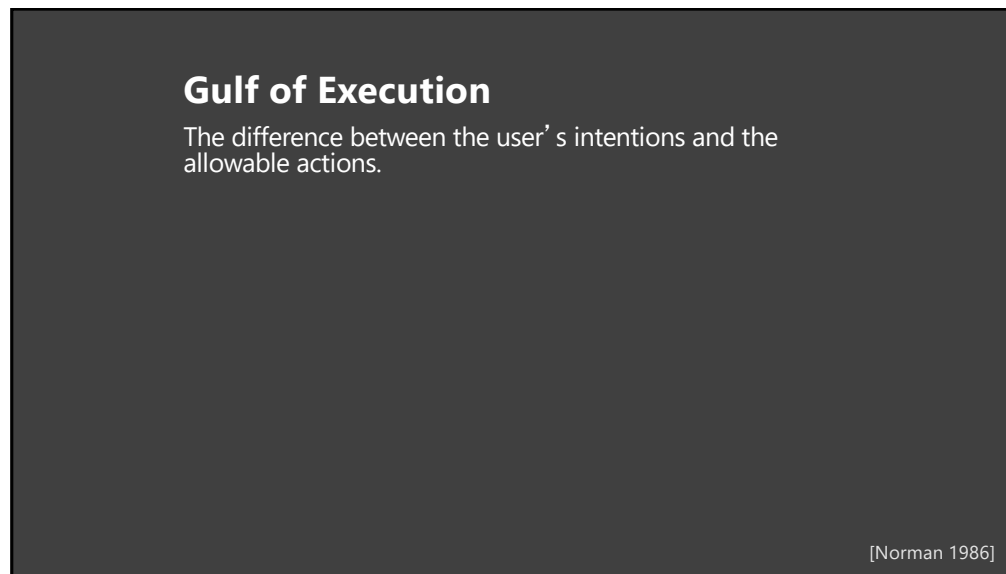
3

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

4



5



6

## Gulf of Execution

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

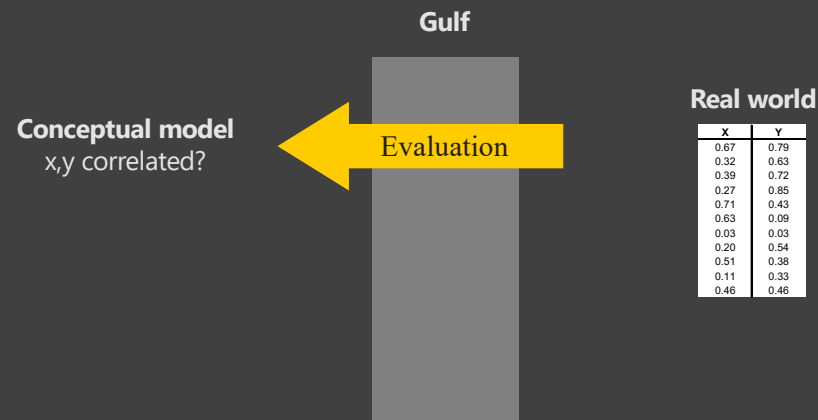
## Gulf of Evaluation

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]

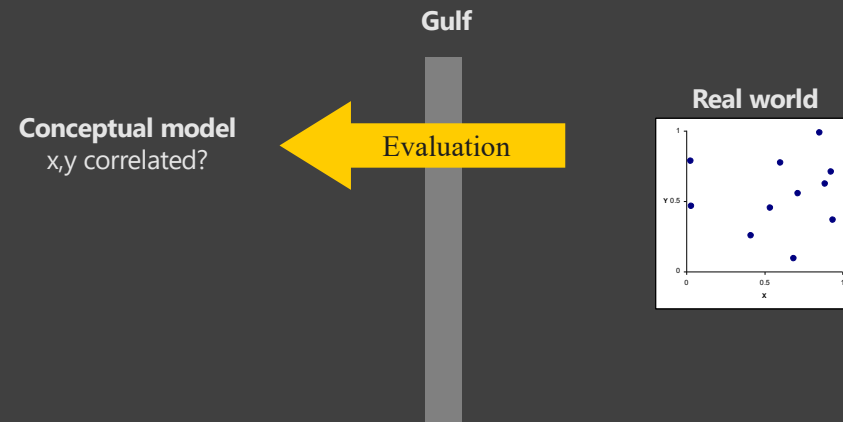
7

## GULF OF EVALUATION



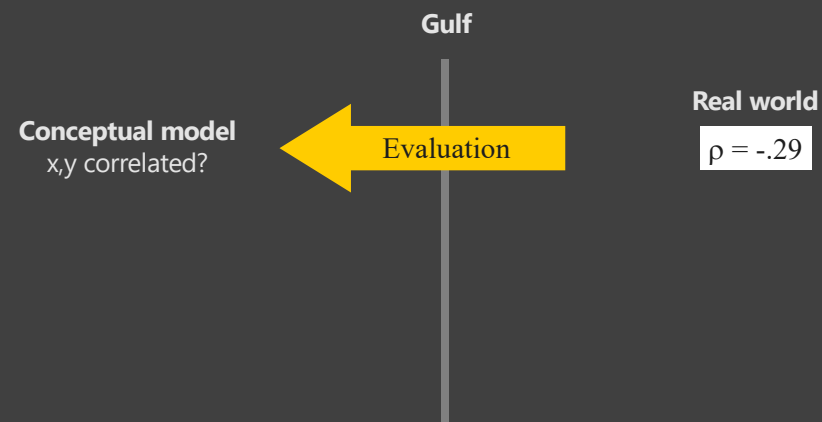
8

## GULF OF EVALUATION



9

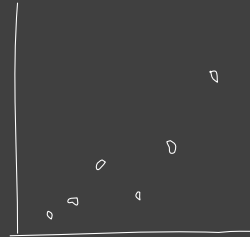
## GULF OF EVALUATION



10

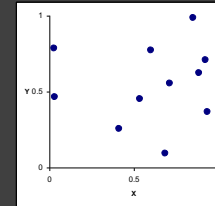
## GULF OF EXECUTION

**Conceptual model**  
Draw a scatterplot



Gulf

Execution



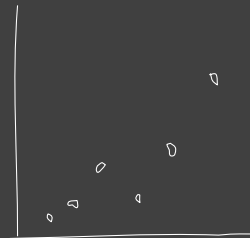
**Real world**

Move 90 30  
Rotate 35  
Pen down  
...

11

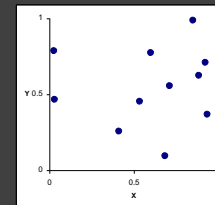
## GULF OF EXECUTION

**Conceptual model**  
Draw a scatterplot

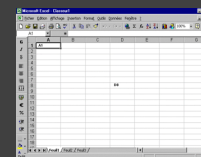


Gulf

Execution



**Real world**



12

## **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]

13

## **EARLY SYSTEMS**

14

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

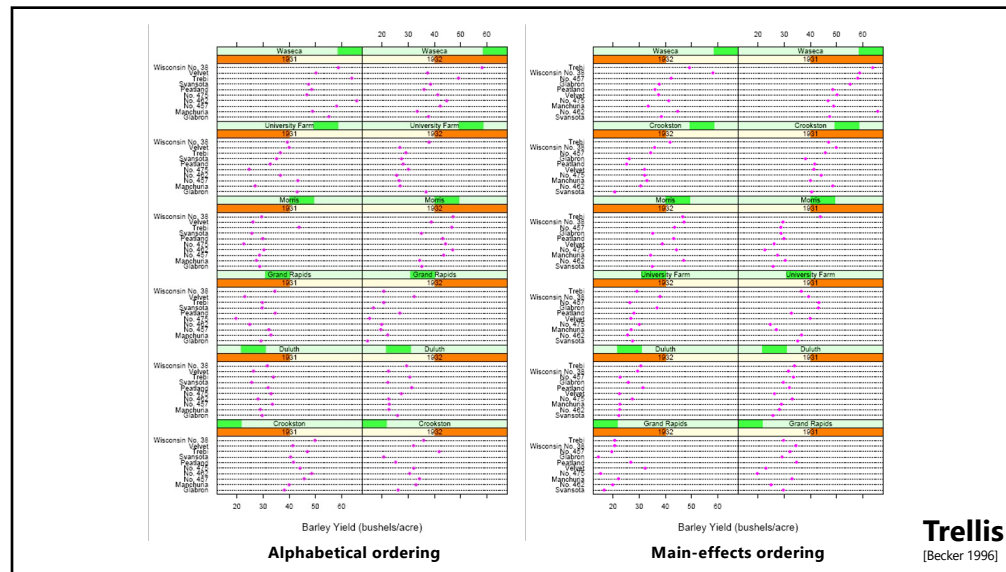
Graphics and Graphic Information Processing [Bertin 81]

15

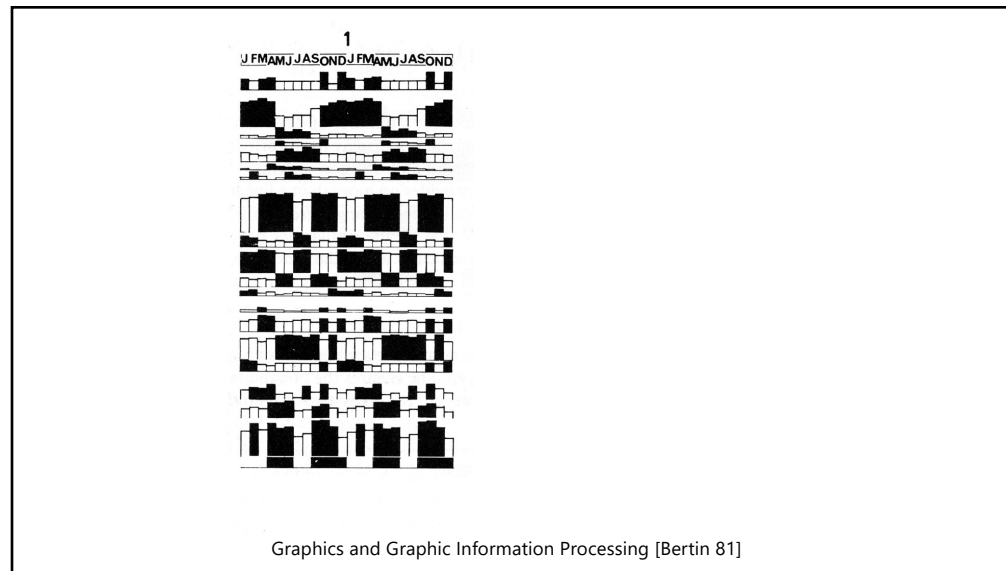
How might we **graphically analyze** the table **without focusing on** the specific numbers?

16





17



18

## GROUP SIMILAR ROWS AND COLUMNS

**Choose a row with a particular visual aspect**

Move to extremity of matrix

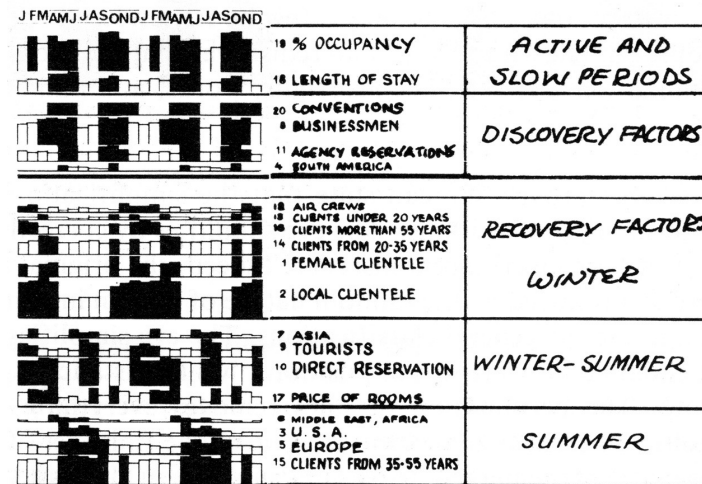
**Move similar rows close, opposite rows to bottom**

Creates two opposing groups and a middle group

**Repeat for columns (can only do this with some kinds of data)**

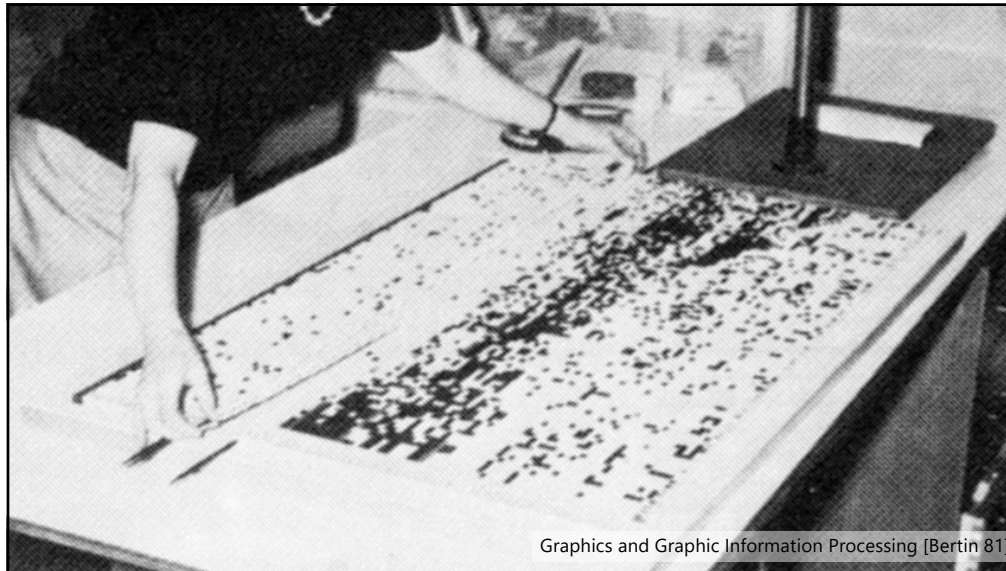
Iterate

19



Graphics and Graphic Information Processing [Bertin 81]

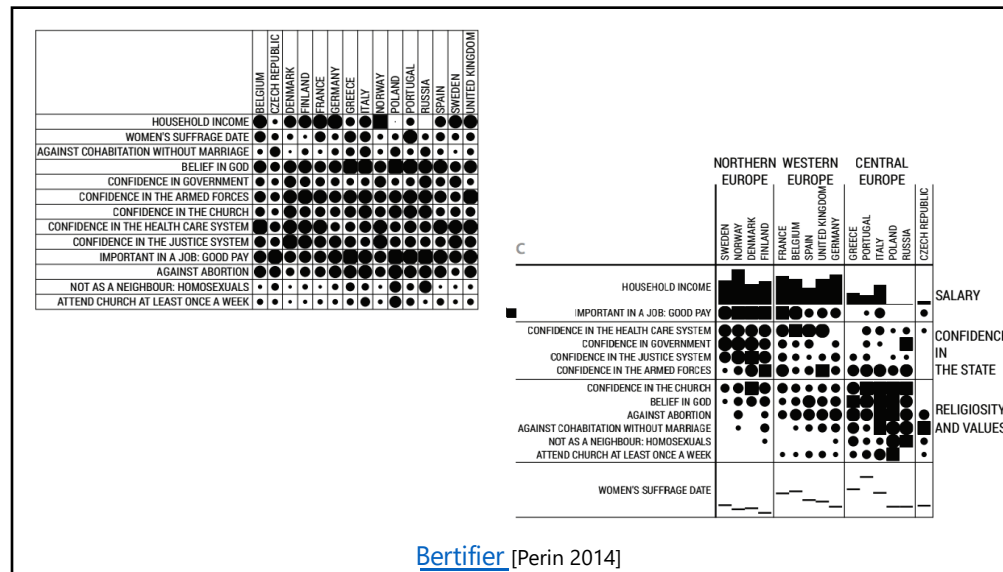
20



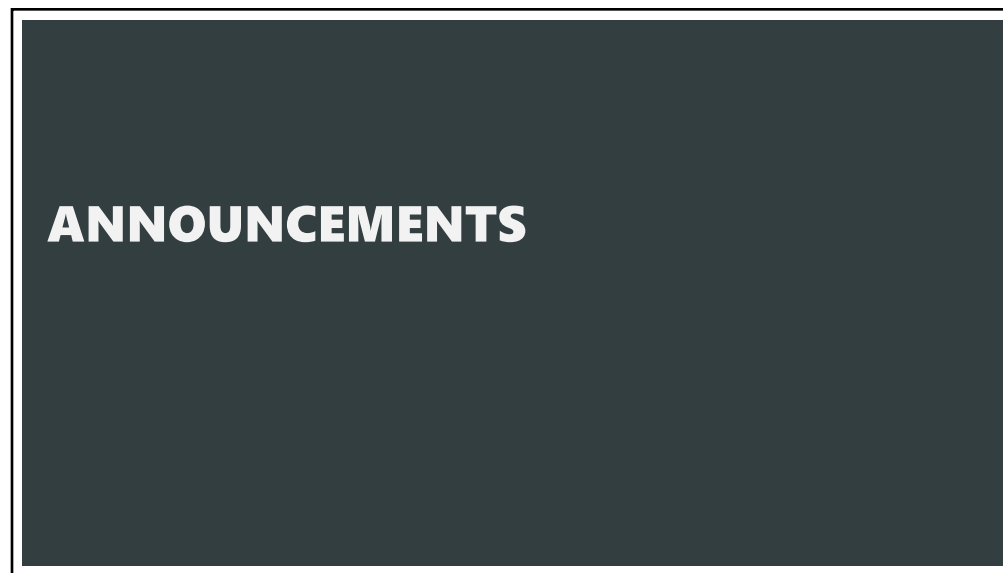
21



23



26



32

## ASSIGNMENT 2: EXP. DATA ANALYSIS

**Due 10/14 10:30am**

Use **Tableau** or **Vega-Lite** to formulate & answer data questions

### First steps

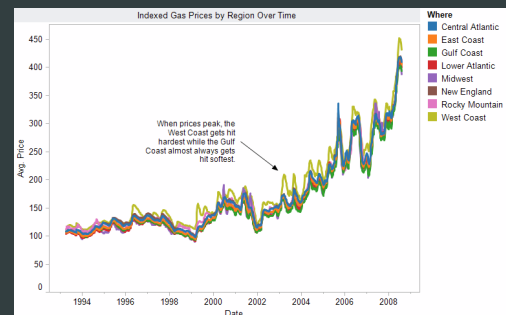
- Step 1: Pick domain & data
- Step 2: Pose questions
- Step 3: Profile data
- Iterate as needed

### Create visualizations

- See different views of data
- Refine questions

### Author a report

- Screenshots of most insightful views (8+)
- Include titles and captions for each view



33

## D3 NOTEBOOKS NEXT MON & WED

**Team** • **Published**  
**Introduction to D3**  
 You republished 14 hours ago

**You** • **Published**  
**Making D3 Charts Interactive**  
 You republished 14 hours ago

35

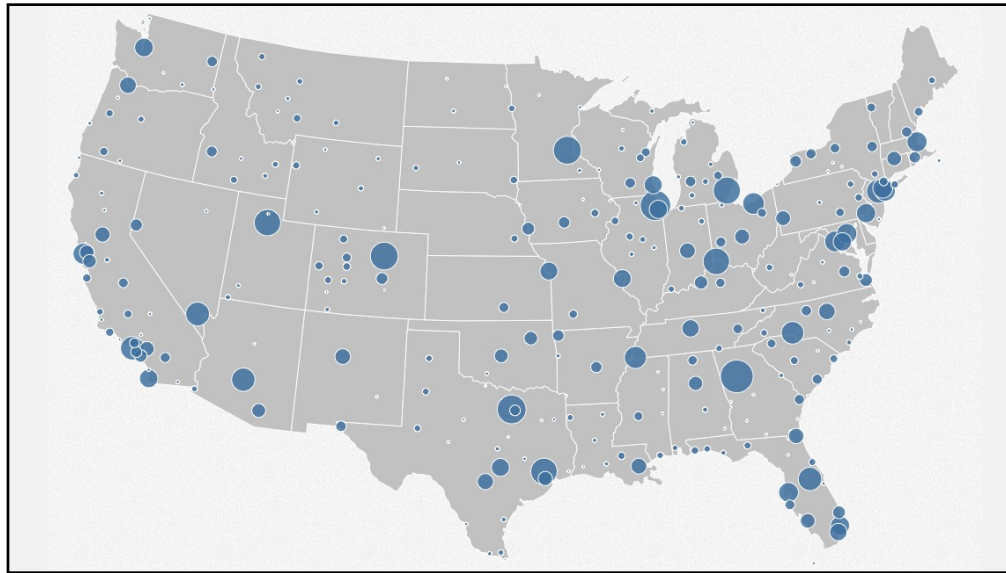
# SELECTION

36

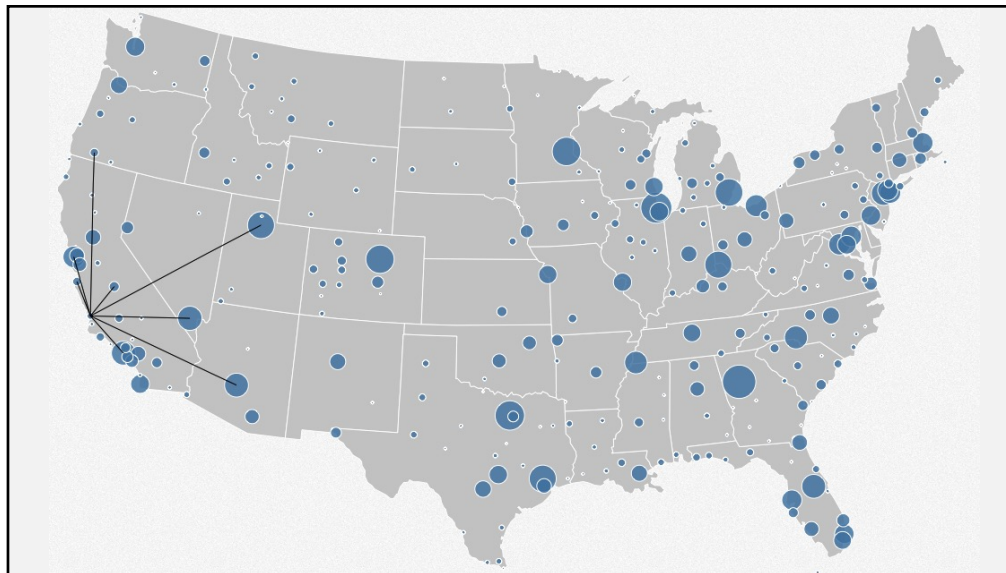
## BASIC SELECTION METHODS

- Point Selection
- Mouse Hover / Click
- Touch / Tap
- Select Nearby Element (e.g., Bubble Cursor)

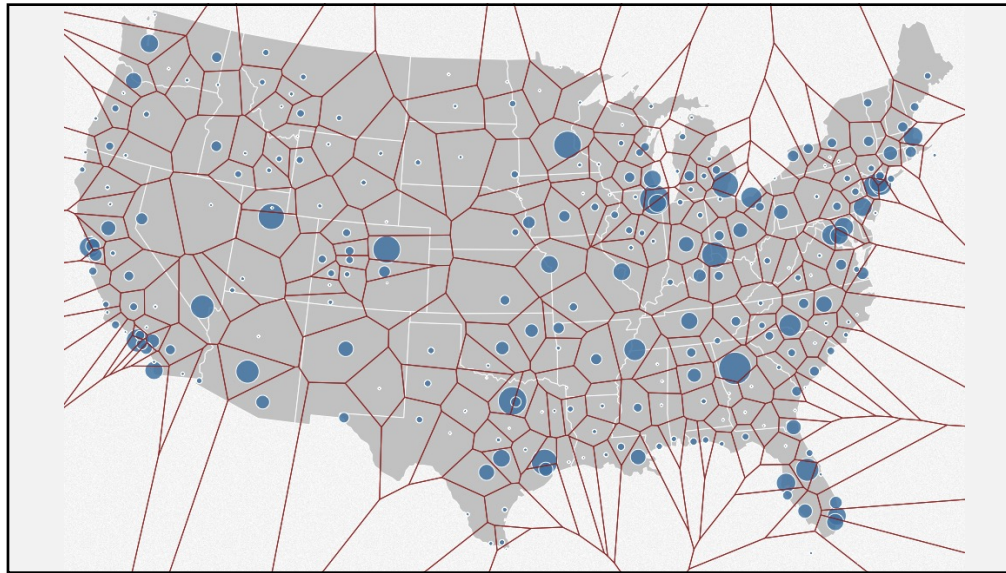
37



38



39



40

## BASIC SELECTION METHODS

Point Selection  
Mouse Hover / Click  
Touch / Tap  
Select Nearby Element (e.g., Bubble Cursor)

Region Selection  
Rubber-band or Lasso  
Area Cursors ("Brushes")

41

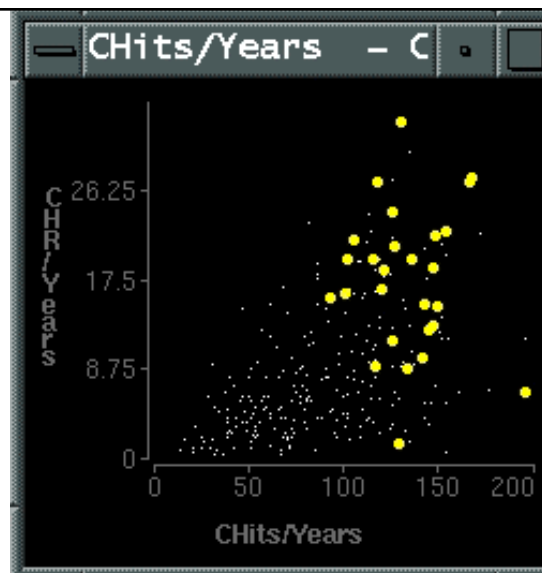


# BRUSHING AND LINKING

42

## BRUSHING

Direct attention to a  
subset of the data [Wills 95]



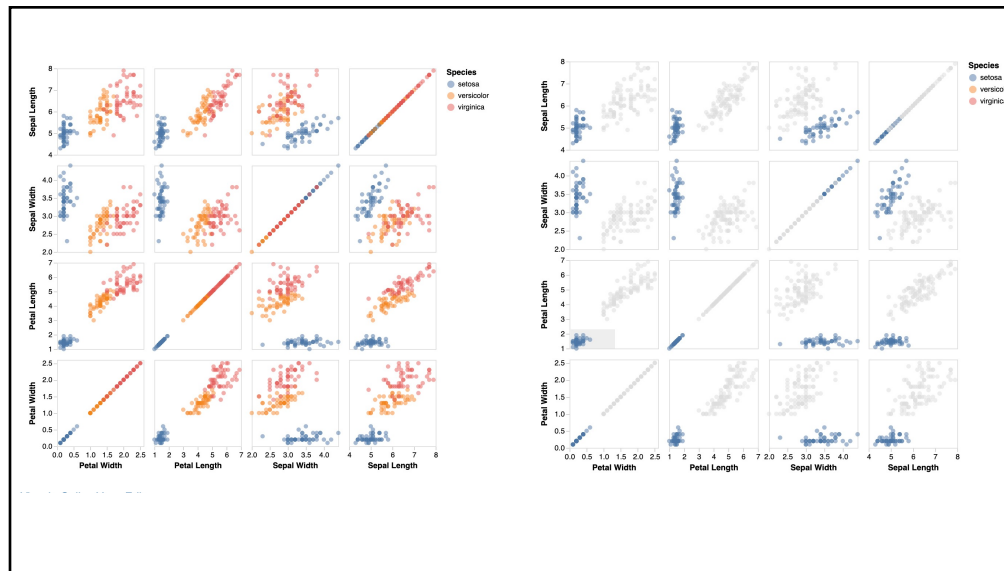
43

## BRUSHING & LINKING

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

The component views must be *linked*  
by *tuple* (matching same data point across views), or  
by *query* (matching range or values of fields)

44



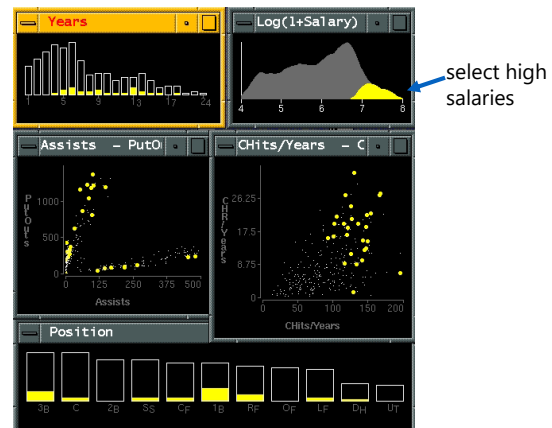
46

## BASEBALL STATISTICS [Wills 1995]



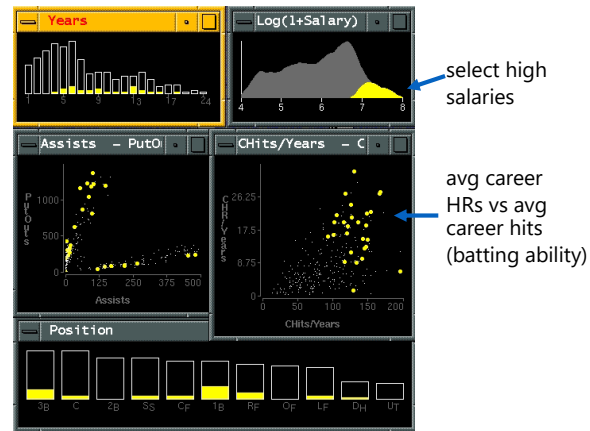
47

## BASEBALL STATISTICS [Wills 1995]



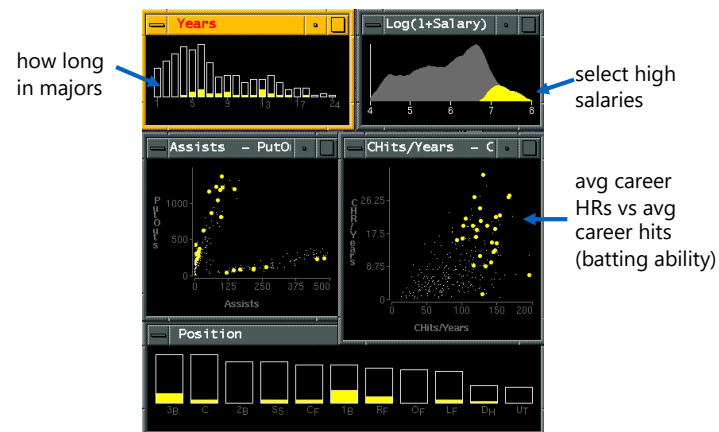
48

## BASEBALL STATISTICS [Wills 1995]



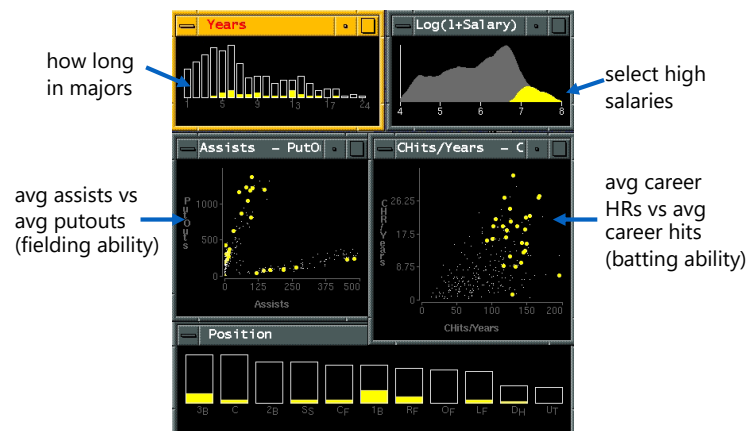
49

## BASEBALL STATISTICS [Wills 1995]



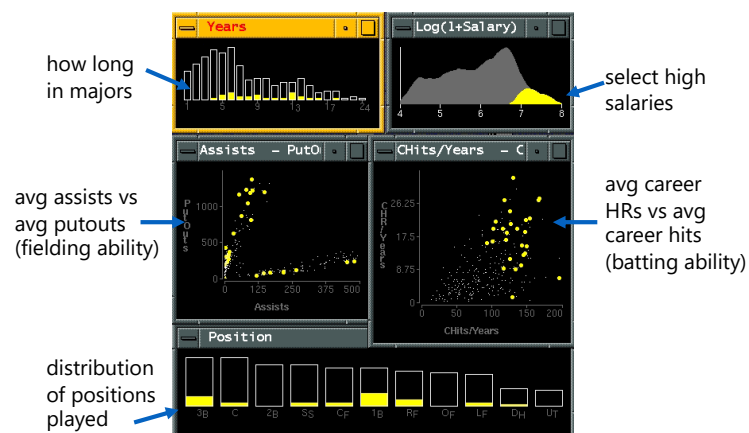
50

## BASEBALL STATISTICS [Wills 1995]



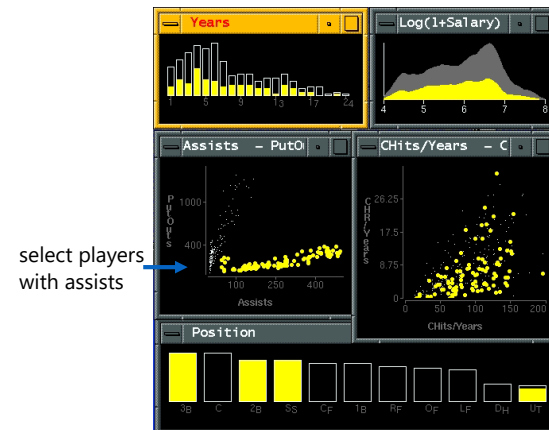
51

## BASEBALL STATISTICS [Wills 1995]



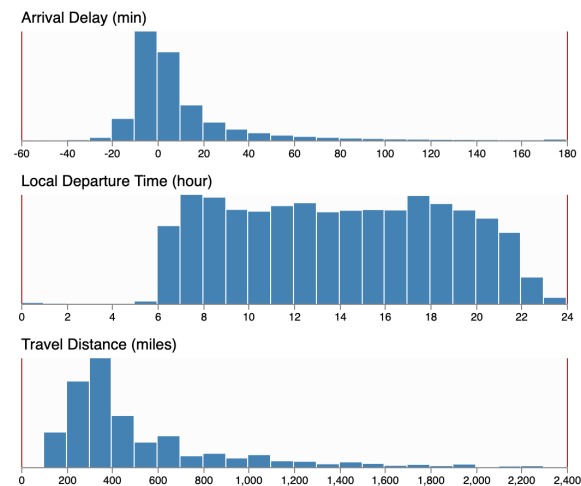
52

## BASEBALL STATISTICS [Wills 1995]



53

## CROSS-FILTERING



54

# DYNAMIC QUERIES

55

## QUERY & RESULTS

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

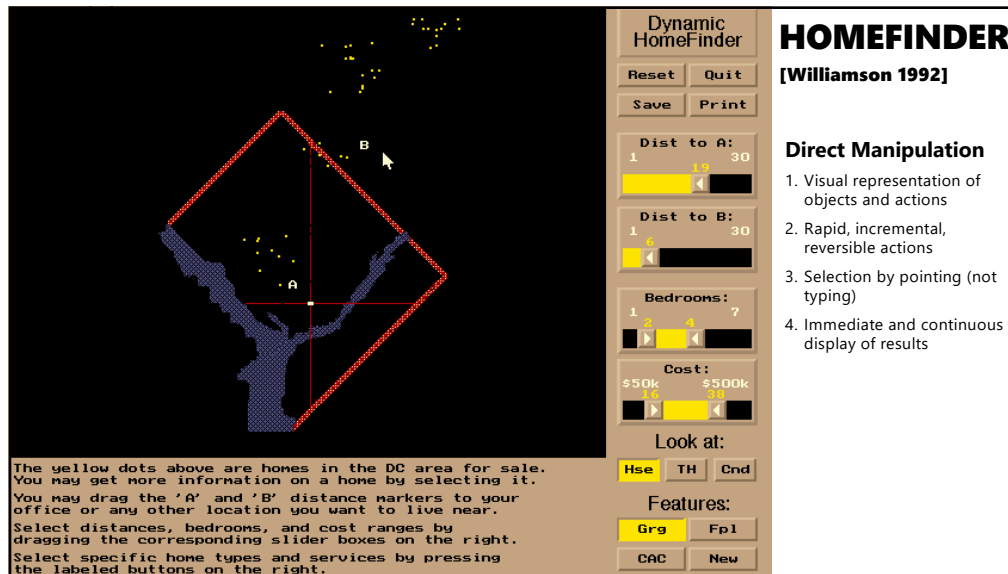
### Issues

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

Dynamic Browser : DC Home Finder

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	5081 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

56



**Dynamic HomeFinder**

**HOMEFINDER**  
[Williamson 1992]

**Direct Manipulation**

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

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.

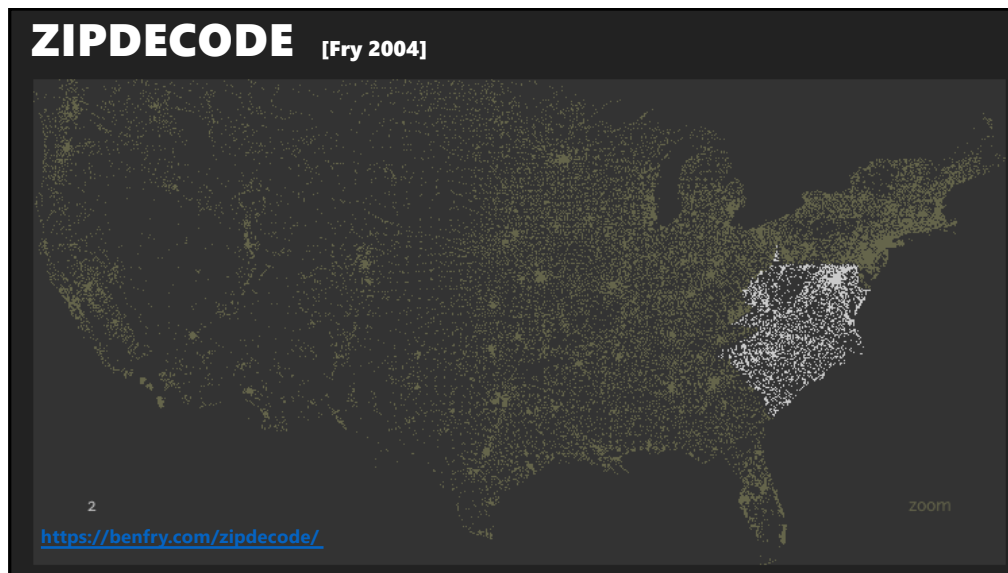
Reset Quit  
Save Print

Dist to A: 1 30  
Dist to B: 1 30  
Bedrooms: 1 7  
Cost: \$50k \$500k

Look at: Hse TH Cnd

Features: Grg Fp1  
CAC New

57

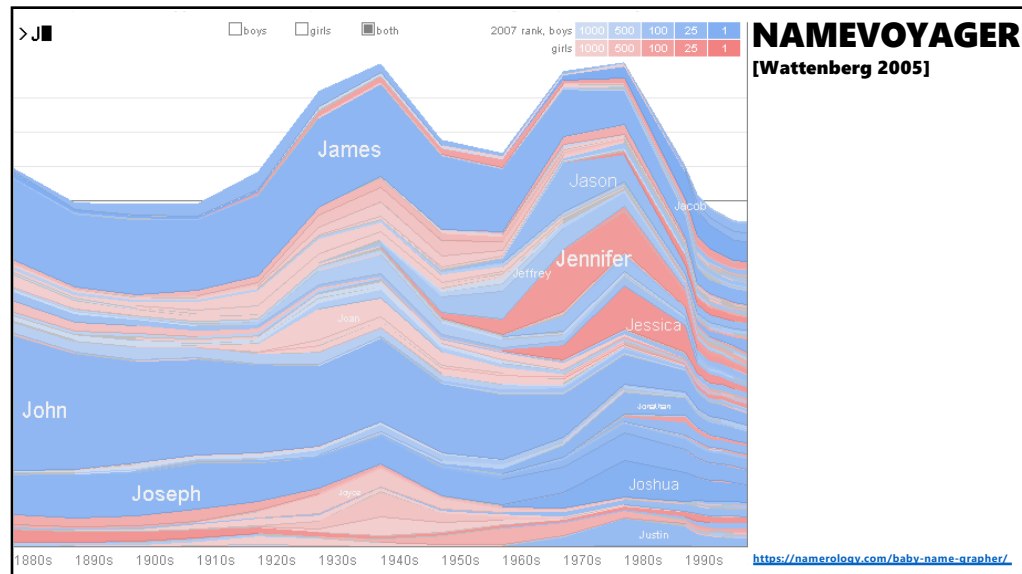


**ZIPDECODE** [Fry 2004]

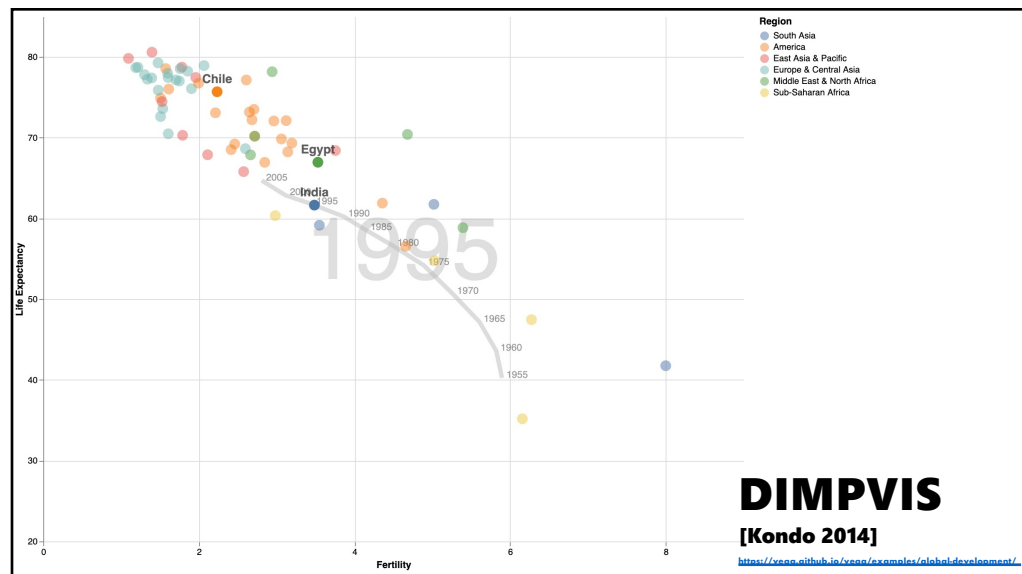
2 <https://benfry.com/zipdecode/> zoom

64

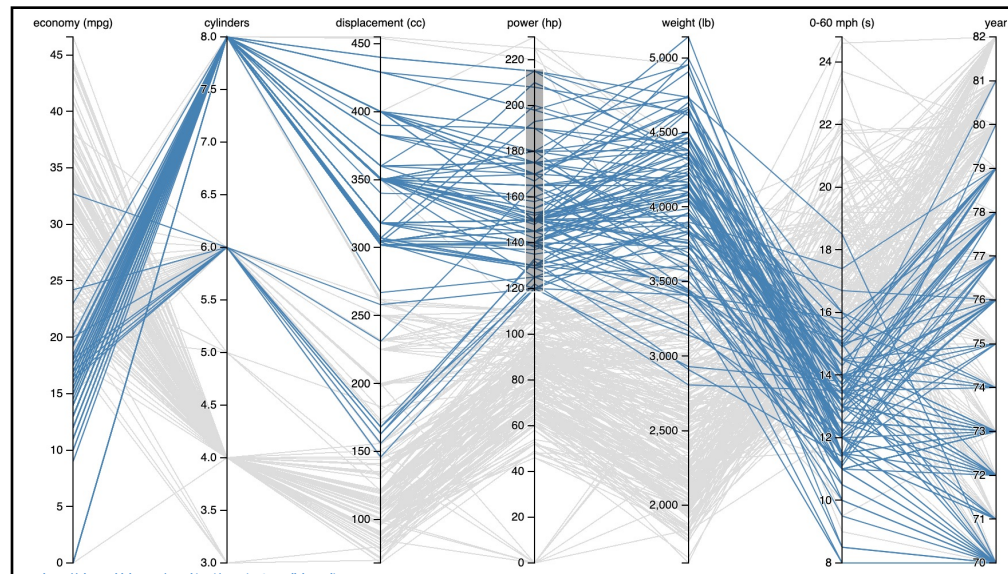




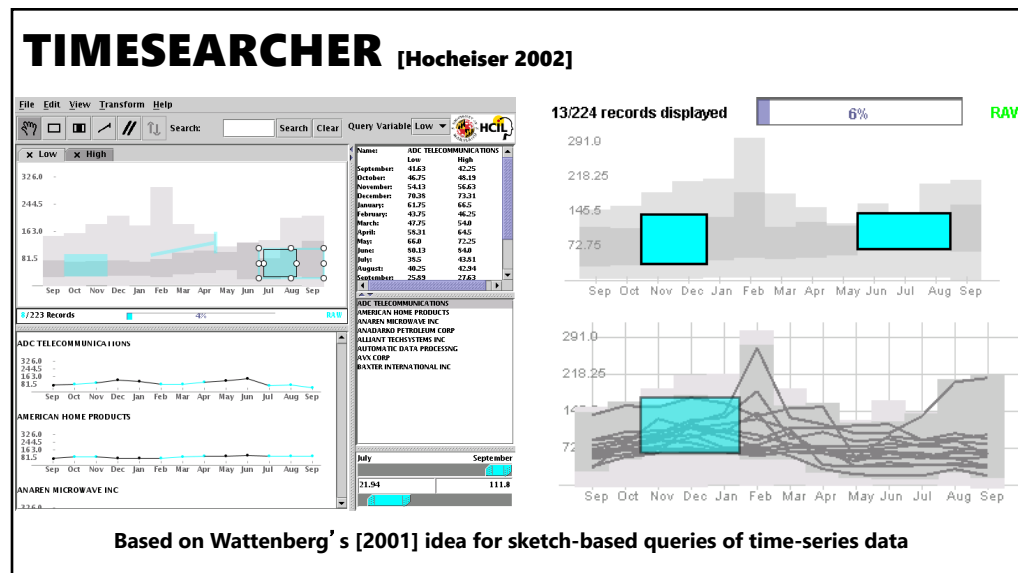
65



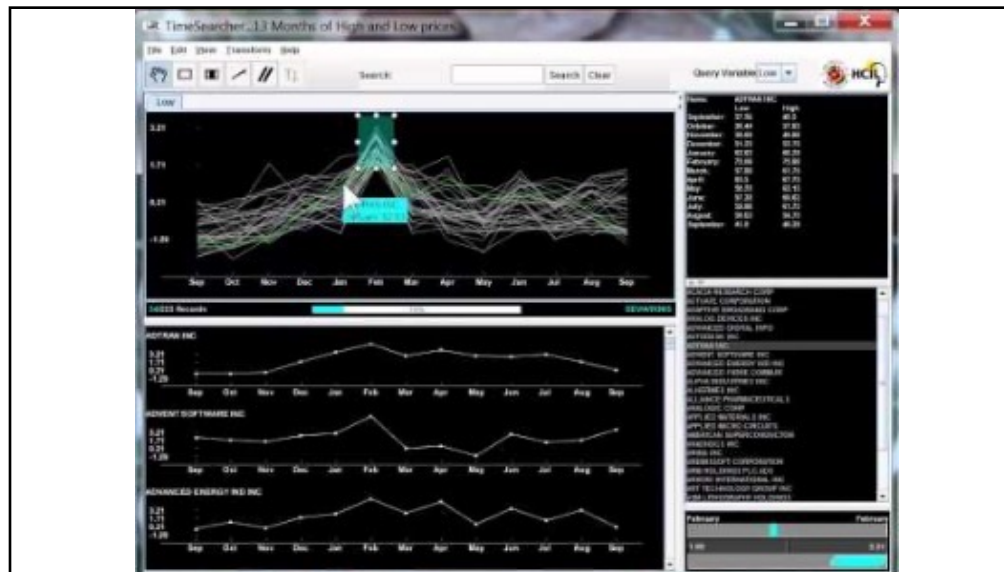
66



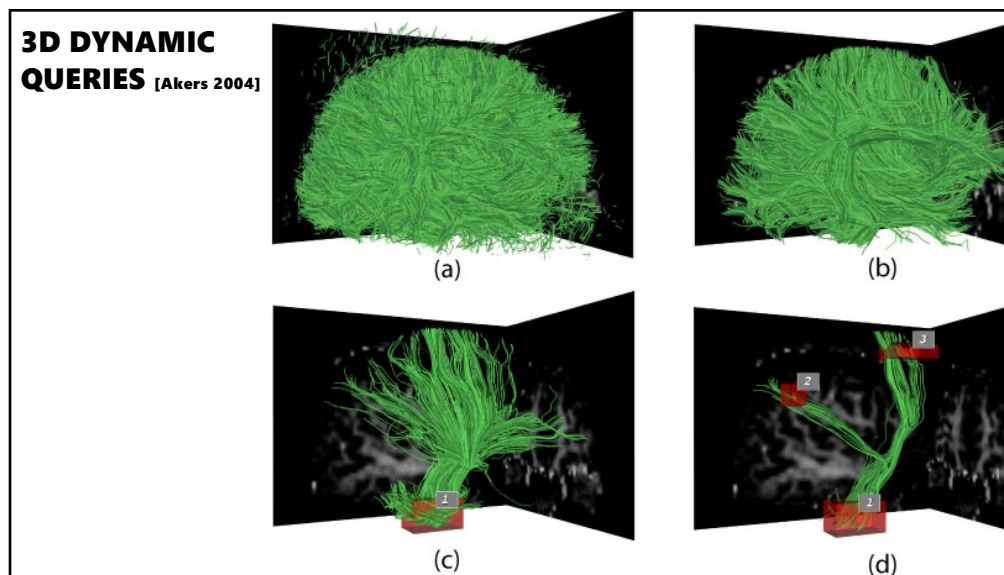
67



68

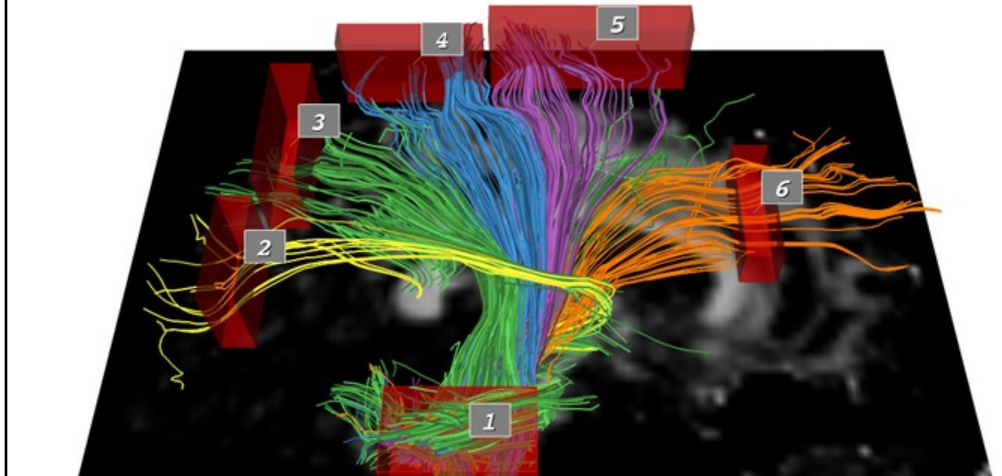


69



70

## 3D DYNAMIC QUERIES [Akers 2004]



71

## DYNAMIC QUERIES PROS & CONS

### Pros

- Controls useful for both novices and experts
- Quick way to explore data

### Cons

- Simple queries
- Lots of controls
- Amount of data shown limited by screen space

72

## **SUMMARY**

### **Good visualizations are task dependent**

Pick the interaction technique to support the task

### **Fundamental interaction techniques**

Selection

Brushing & Linking

Dynamic Queries