Multidimensional Visualization II

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HAiV

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- **Slides in this course courtesy of**
  - Dr. Abish Malik (Purdue)
  - Dr. Yun Jang (Sejong Univ.)
  - Dr. Ross Maciejewski (ASU)
  - Dr. Niklas Elmqvist (UMD)
  - Dr. David Ebert (Purdue)

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Data Dimensions

- **Common dimensions: 1, 2, 3**
  - 1 dimension – univariate
    - Temperature readings
  - 2 dimensions – bivariate
    - Positions on map (lat/long)
  - 3 dimensions – trivariate
    - Positions in space (3D)
- **For more than 3 dimensions**
  - Hypervariate

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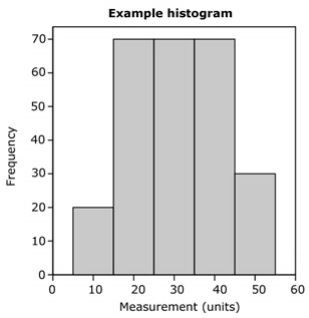
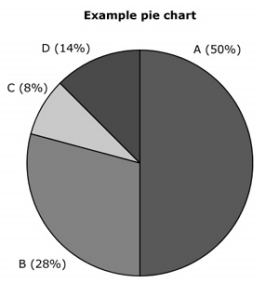
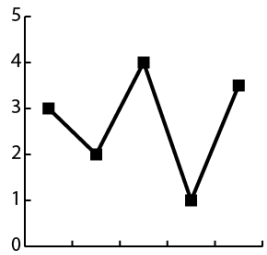
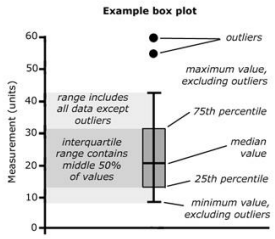
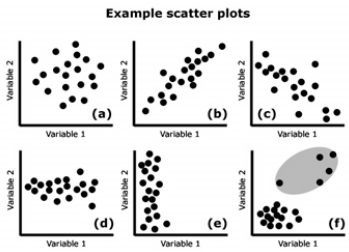
Visual Representations: Low Dimension Data











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Hypervariate Data?

- **For data with >2 variables, we must project down to 2D**
- **Come up with visual mapping that locates each dimension into 2D plane**
- **Computer graphics: 3D → 2D projections**

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Table View

- **Projecting hypervariate data on a spreadsheet**
  - Variable → Column
  - Data cases in rows
- **Other techniques?**

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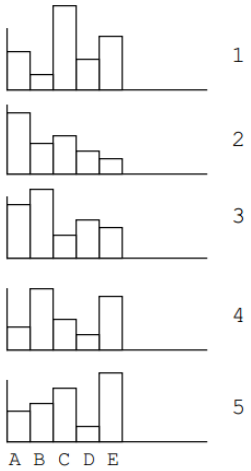
Multiple Views

Display for each variable

	A	B	C	D	E
1	4	1	8	3	5
2	6	3	4	2	1
3	5	7	2	4	3
4	2	6	3	1	5
5	3	4	5	1	7



[John Stasko]

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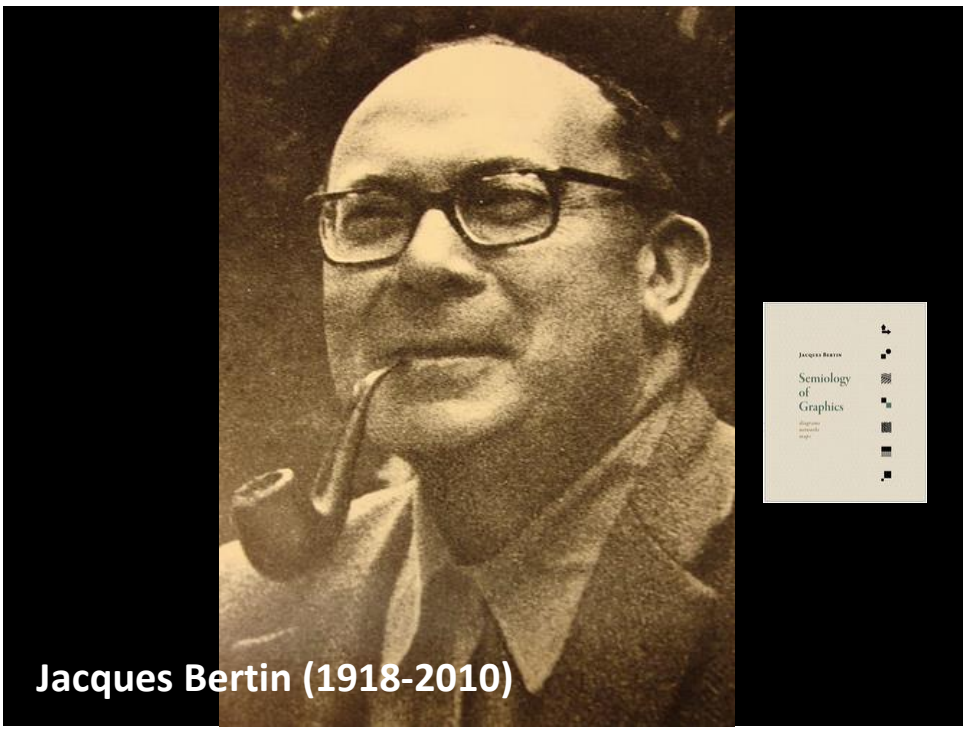

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Visual Variables

IVSTAOAZNULI → VISUALIZATION

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Bertin's Visual Variables

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Bertin's Original Visual Variables	
Position changes in the x, y location	
Size change in length, area or repetition	
Shape infinite number of shapes	
Value changes from light to dark	
Colour changes in hue at a given value	
Orientation changes in alignment	
Texture variation in 'grain'	

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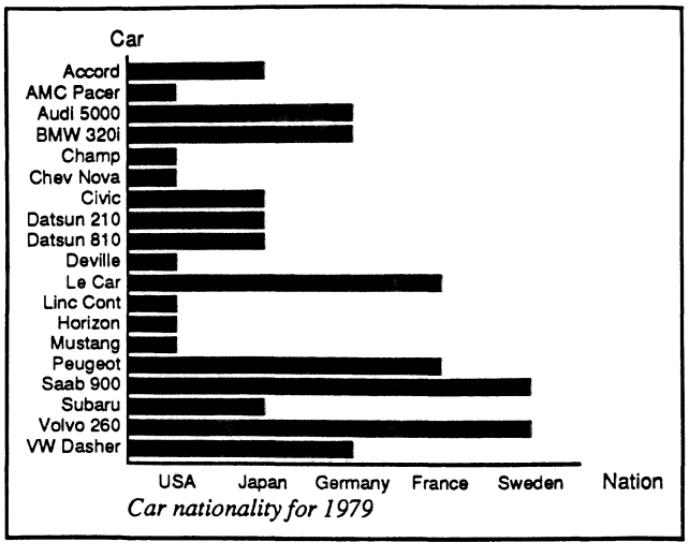
Which is more effective?



[Mackinlay, 1986]

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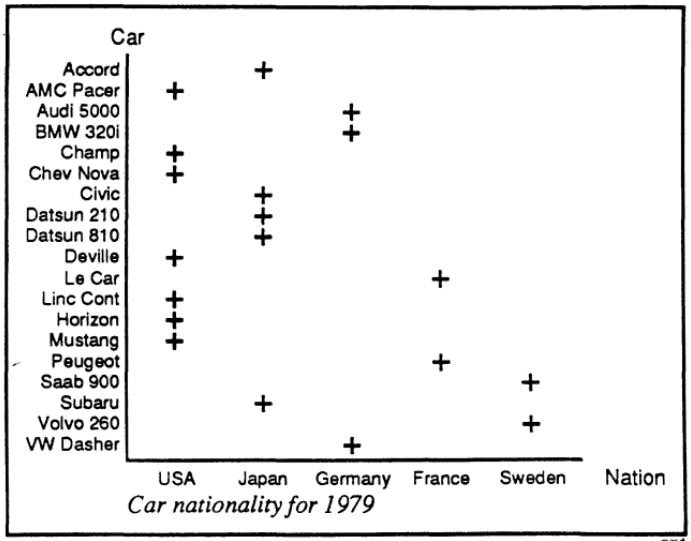
Which is more effective?



[Mackinlay, 1986]

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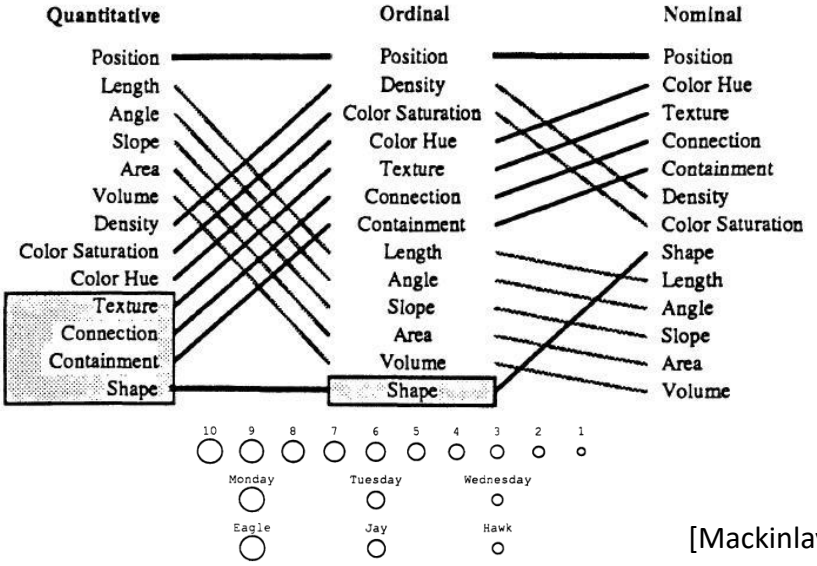
Visual Variables (Jock Mackinlay)



[Mackinlay, 1986]

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Cleveland and McGill (1984)

Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods

William S. Cleveland; Robert McGill

Journal of the American Statistical Association, Vol. 79, No. 387. (Sep., 1984), pp. 531-554.

Stable URL:
http://links.jstor.org/sici?sici=0162-1459%28198409%2979%3A387%3C531%3AGPTEAA%3E2.0.CO%3B2-Y

Journal of the American Statistical Association is currently published by American Statistical Association.

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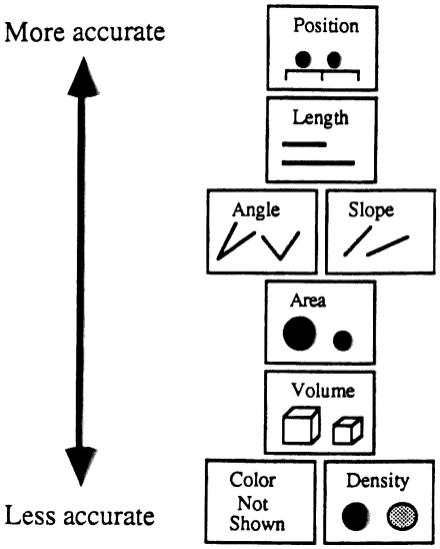
Cleveland and McGill (1984)



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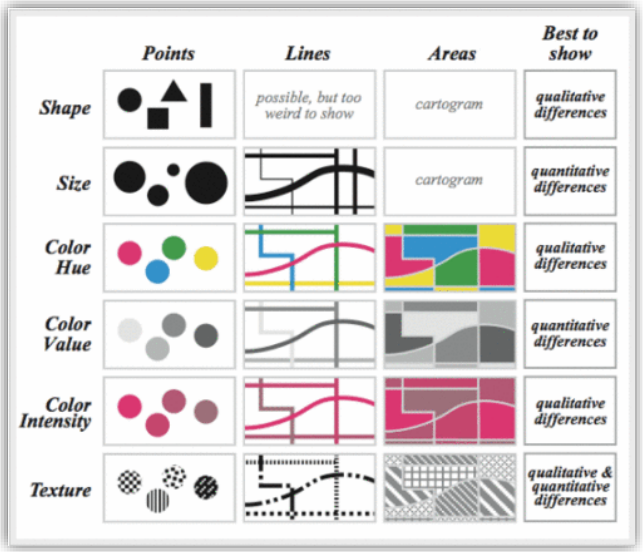
Summary: Visual Variables

- Position
- Length
- Area
- Volume
- Texture
- Color
- Orientation
- Shape

- ~10 dimensions?



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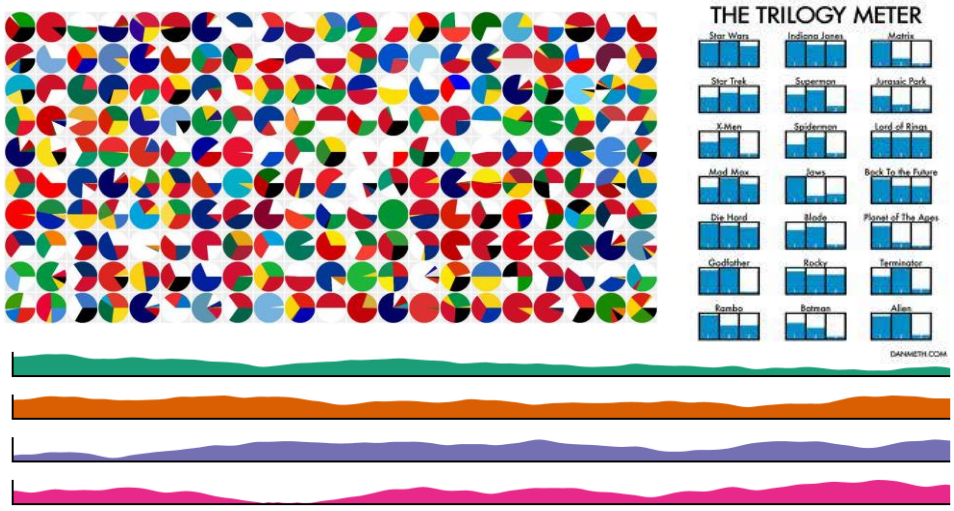
Small Multiples

- Give each variable a graph of its own!



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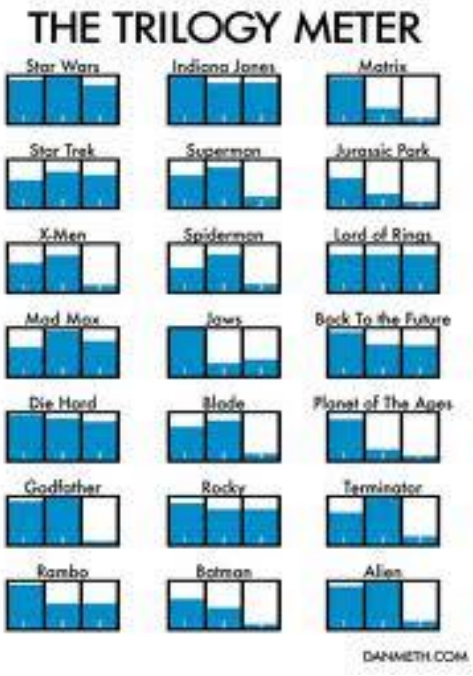
Small Multiples



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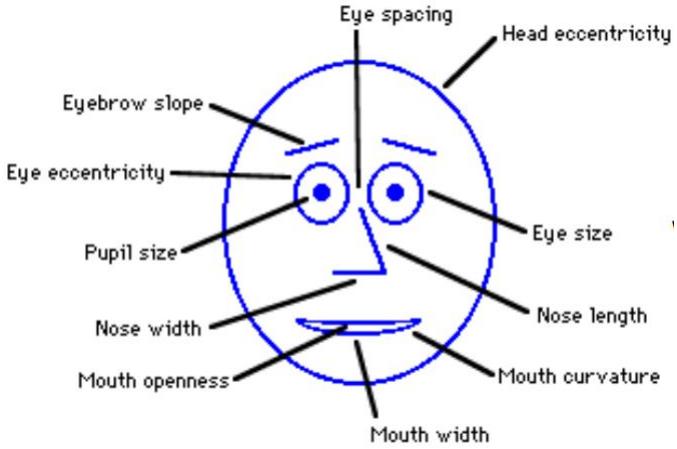
Chernoff Faces (1973)

- Utilize human face recognition
- Visualize n-D data (glyphs)



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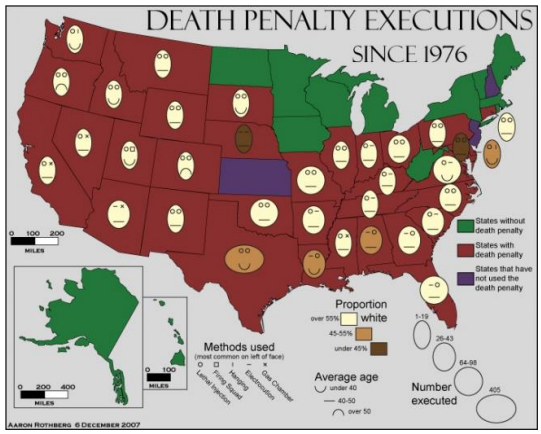
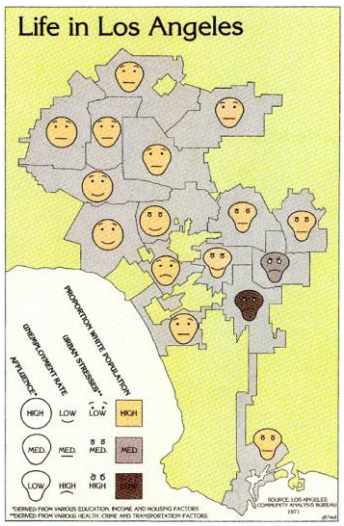
Chernoff Faces (1973)





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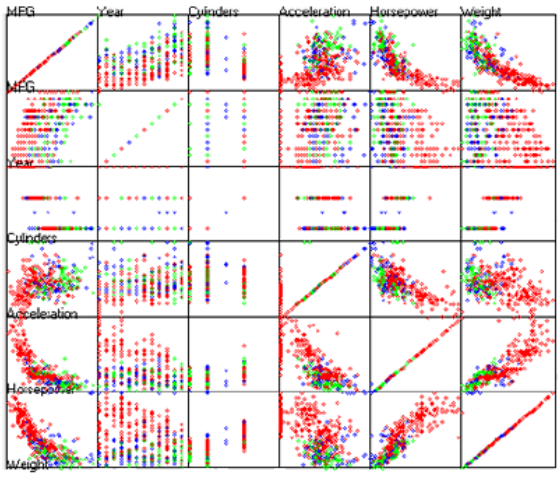
Scatterplot Matrices (SPLOM)

- **2D scatterplots for all combinations of dimensions**
- **Car data set**



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ScatterDice (Elmqvist 2008)

- **SPLOMs explored by others, but Elmqvist et al. add a twist:**
  - Use matrix as a space for navigation
  - Visual exploration becomes a navigation problem
- **Result: Visualize complex data through sequence of simple visualizations**

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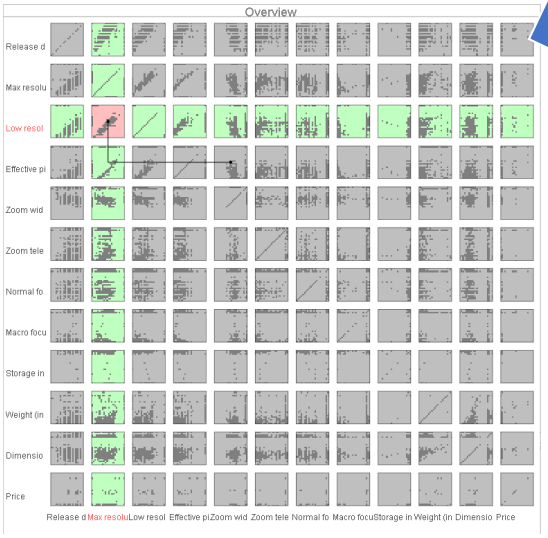
Example: Scatterplot Matrix



Video!

https://www.youtube.com/watch?v=E1birsp9iYk#t=24

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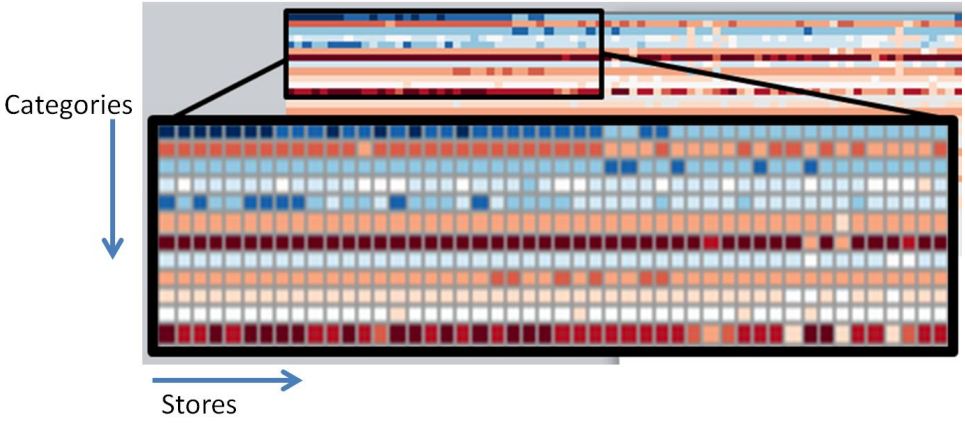
Pixel-based Matrix Views

- **2D scatterplots for visualizing data**



[Ko, 2012]

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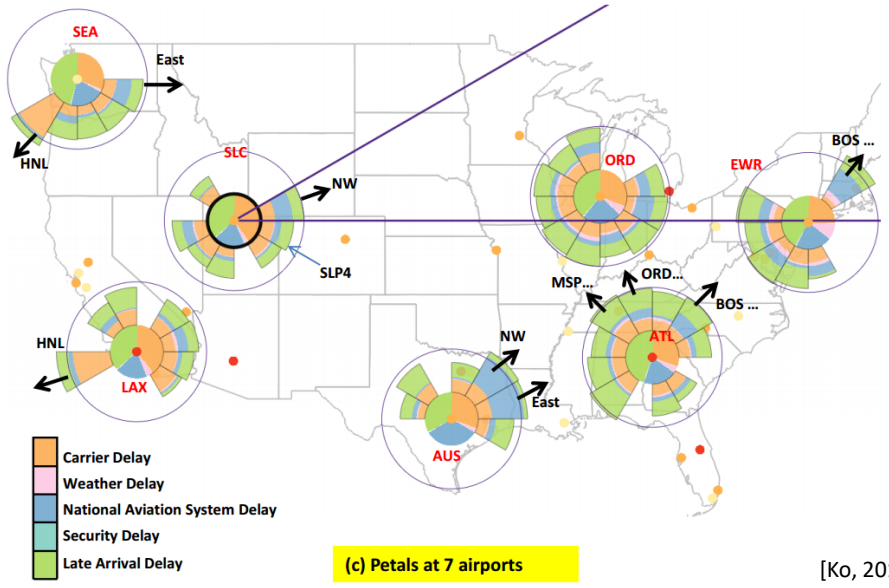
Petals Visualization for Multivariate Data



(c) Petals at 7 airports

[Ko, 2014]

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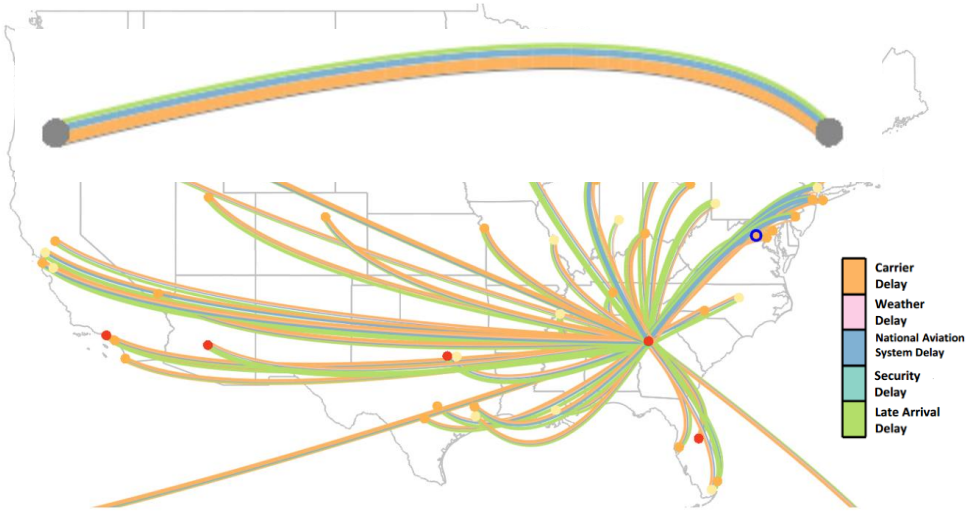
Threads Visualization



https://vimeo.com/102601047

[Ko, 2014]

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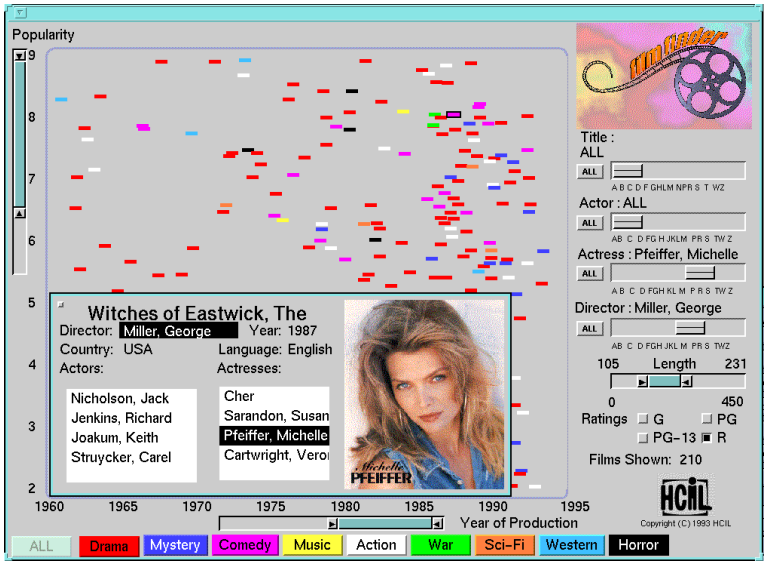
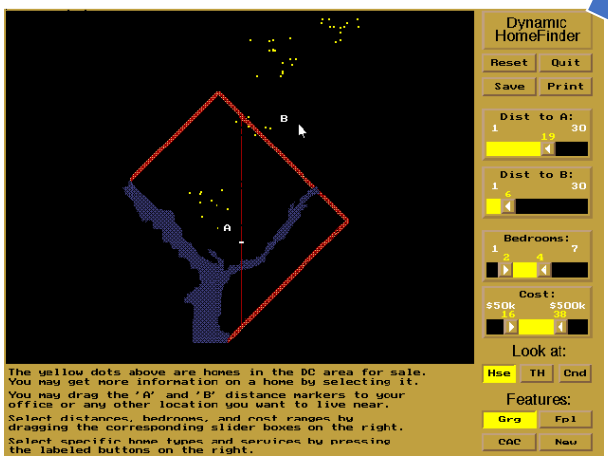
Dynamic Queries

- **Ben Shneiderman in 1990s:**
  - SQL queries are cumbersome
  - Difficult syntax
  - Conversation, not direct
- **Start with sliders, extend them**

Film Finder, (CHI 1994)



Home Finder (1992 MS-DOS app.)



Video!

https://www.youtube.com/watch?time_continue=213&v=5X8XY9430fM

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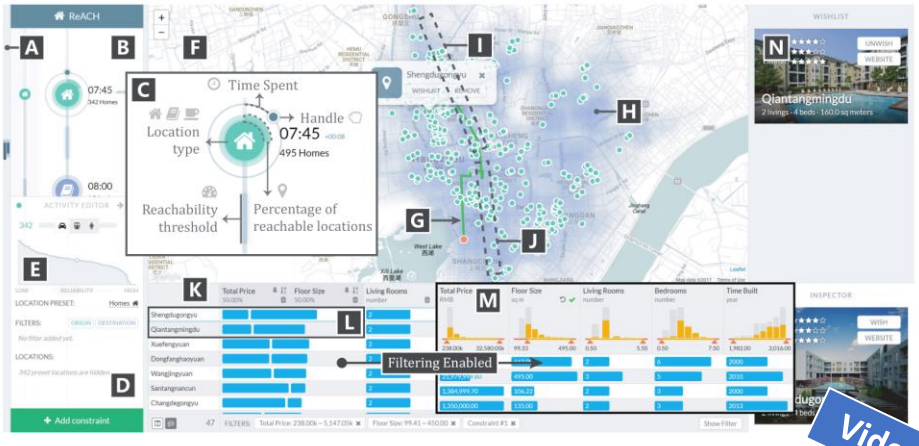
Home Finder Revisited!



Video!

https://www.youtube.com/watch?v=WcjMXAfuygg

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Parallel Coordinates

- **Designed by Alfred Inselberg in 1985**

	V1	V2	V3	V4	V5
D1	7	3	4	8	1
D2	2	7	6	3	4
D3	9	8	1	4	2

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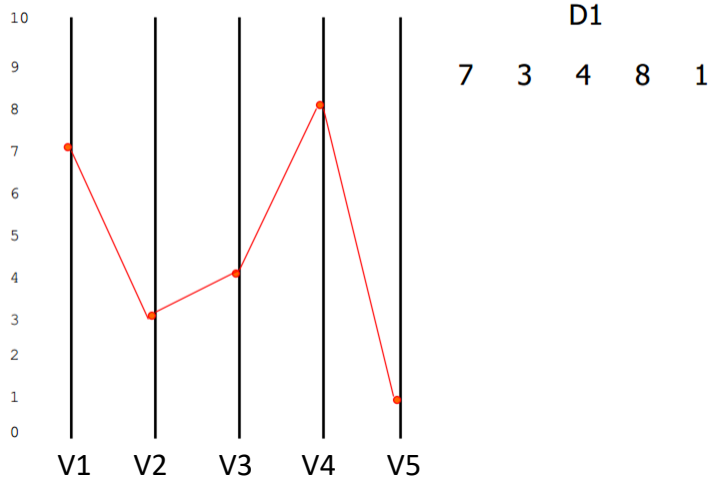
Parallel Coordinates: Idea



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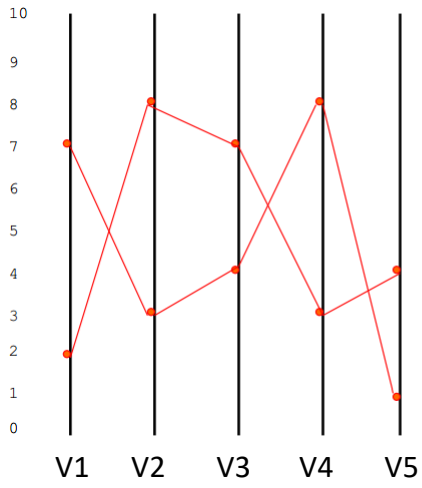
Parallel Coordinates: Idea



D2

2 7 6 3 4

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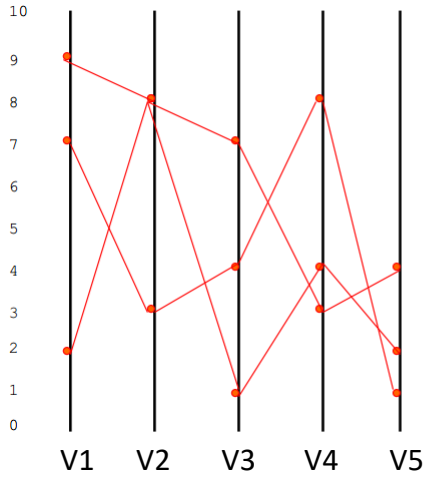
Parallel Coordinates: Idea



D3

9 8 1 4 2

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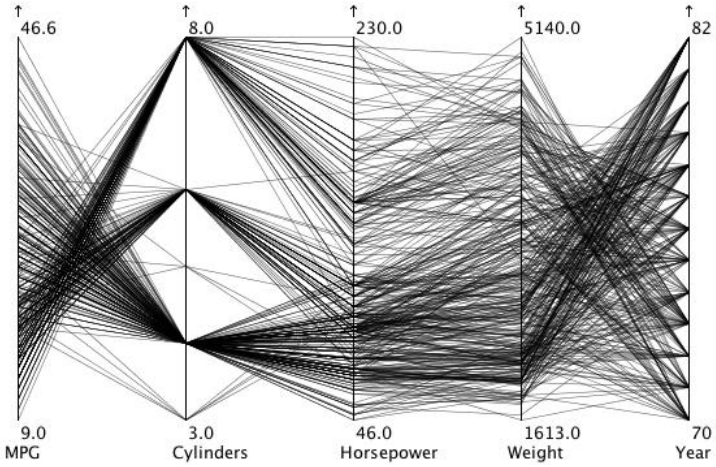
Parallel Coordinates



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Questions?

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