IAT 355
Visualization

Interaction

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Lyn Bartram

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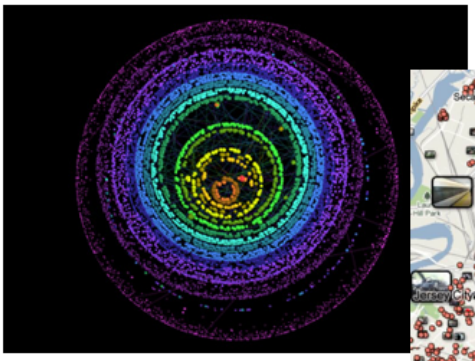
SCHOOL OF INTERACTIVE ARTS + TECHNOLOGY

All techniques fail at some point



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When is static not enough?

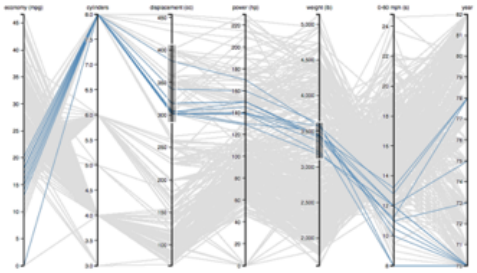
- Scale
  - Too much data
  - Too many dimensions
- Story telling
  - Guided tour
- Exploration
  - Flexible paths and combinations of views
- Learning
  - We learn better when we actively manipulate and engage alternatives

What to do with too much data?

pack all the data in one complex representation

use interaction to reveal different subsets of the data

Partition the data into multiple views



http://bl.ocks.org/jasondavies/raw/1341281/

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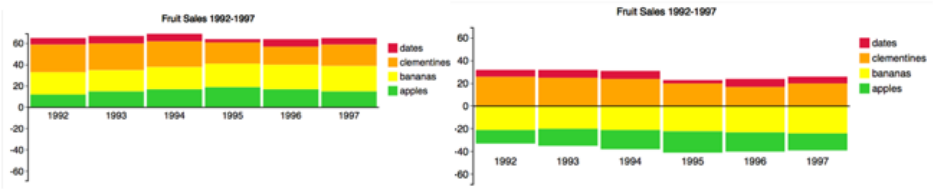
Keim, Daniel A., and Hans-Peter Kriegel. "VisDB: Database exploration using multidimensional visualization." Computer Graphics and Applications, IEEE 14.5 (1994): 40-49.

M. Bostock. Parallel Coordinates in d3,

Stephen Few: Data Visualization for Human Perception. n Soegaard, Mads and Dam, Rikke Friis (eds.). The Encyclopedia of Human-Computer Interaction, 2nd Ed.

Even a simple interaction can be quite powerful

Dancing histogram demo



http://bl.ocks.org/marcdhansen/1ace92ea6344aa05bbac

A stacked histogram allows three judgements: (i) the trends on the total height of the columns, (ii) the proportion of each category within each column and (iii) the trends in the lowest category. The trends, or even inter-column comparisons for any other category is very difficult as the blocks are at different heights.

The interactive stacked histogram solves this problem by allowing different trends to be analysed using the same dynamic graph. It is an example of a general princple of adding interactivity to existing paper visualisations.

Interaction

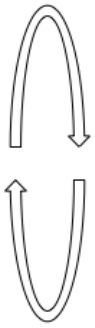
J. Heer and B. Shneiderman. Interactiive Dynamics for Visual Analysis. ACM Queue, 2012.

Specify view

- Encode (visualize)
- Arrange
- Extract
- Derive New

Manipulate view

- Select items to highlight, query
- Explore data for patterns at different levels
- Coordinate and organize views
- Emphasize

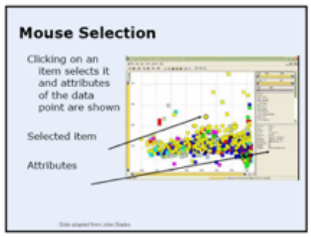


Interaction Techniques

- Filter
- Layout
- Sort
- Brushing and linking
- Arrange data
- Navigate
- Annotate
- Calculate new values
- Reconfigure
- Dynamic queries

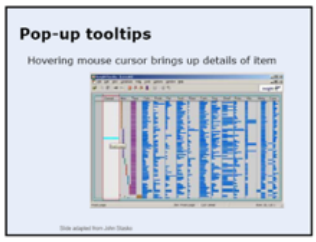
essential interactive operations for supporting exploration

Selection



Direct (basic pointing)

- Point, area, lasso
- “nearby” (bubble cursor)
- Click, touch, hold, hover

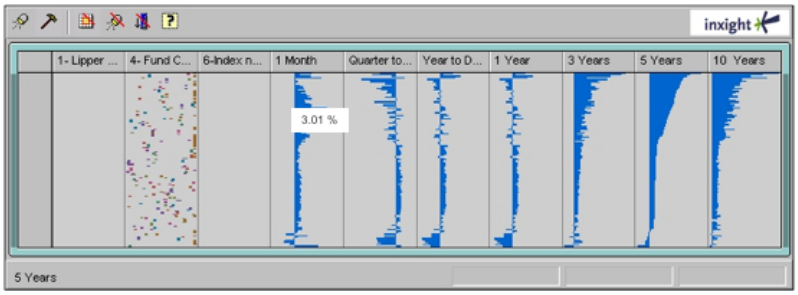


Partial or gradual selection

- Pop up tooltips
- Hovering brings up details of item

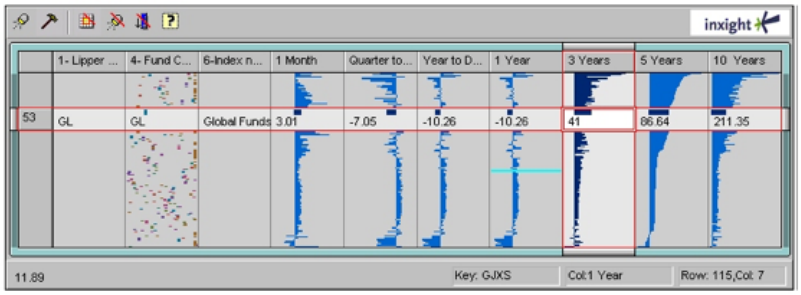
Gradual selection

- Hovering mouse cursor brings up details of item



Gradual selection

- More details are displayed upon selection



So the thing to note here is that while there is a simple selection the resulting operation may not be trivial

Annotation

- Capture mechanism for documenting process and insights
- Adds new data

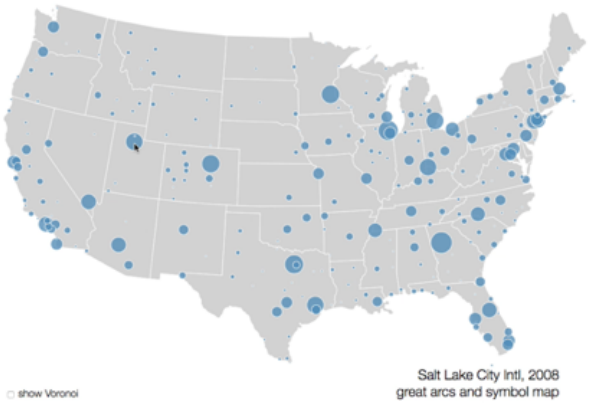
Annotation Graphs: A Graph-Based Visualization for Meta-Analysis of Data based on User-Authored Annotations

N. Diakopoulos. Storytelling with Data: Context is King.

Heer, J., Viégas, F. and Wattenberg, M. "Voyagers and voyeurs: supporting asynchronous collaborative information visualization." Proceedings of ACM CHI 2007. ACM.

Selection can be specific or broad

Pointing, “tooltips” and annotation



http://mbostock.github.io/d3/talk/20111116/airports.html

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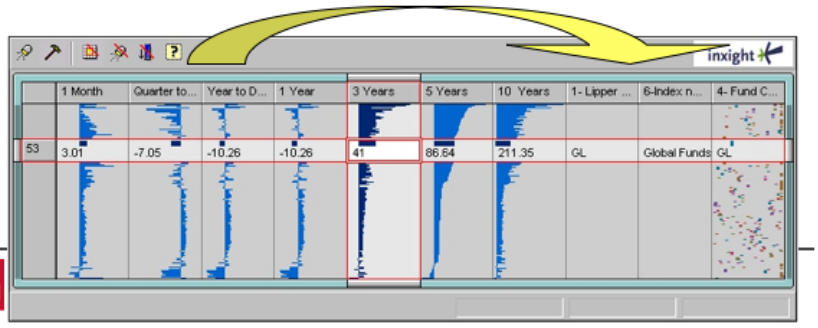
Show with Voronoi, not just about selecting but about extracting

Reconfigure: Rearrange View

- Keep same fundamental representation and what data is being shown, but rearrange elements
  - Alter positioning
  - Affects alignment



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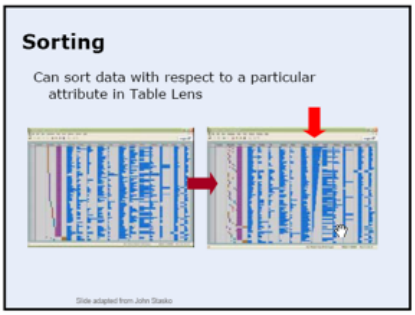
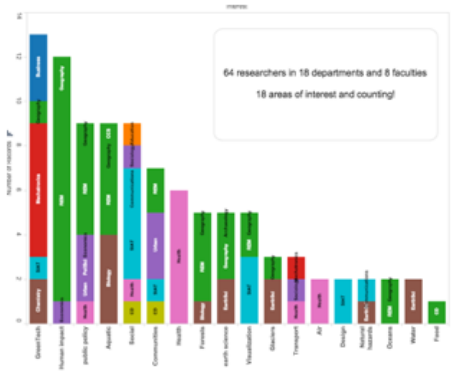
Sorting





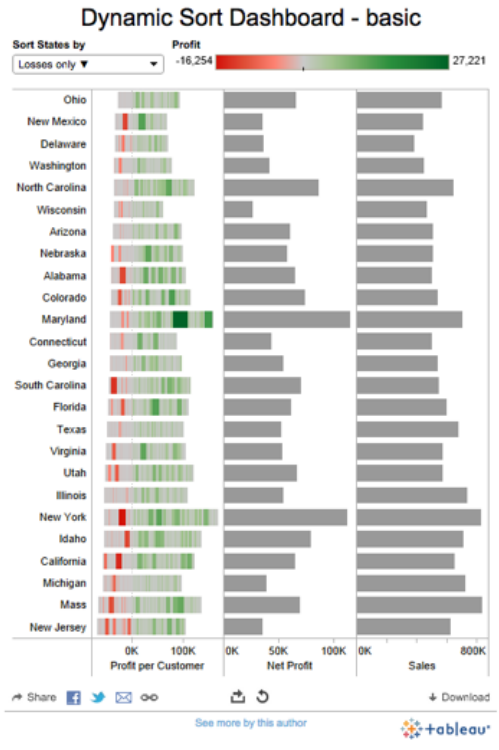
https://public.tableau.com/profile/lyn.bartramn#!/vizhome/SFUClimateResearchFinal/Bars

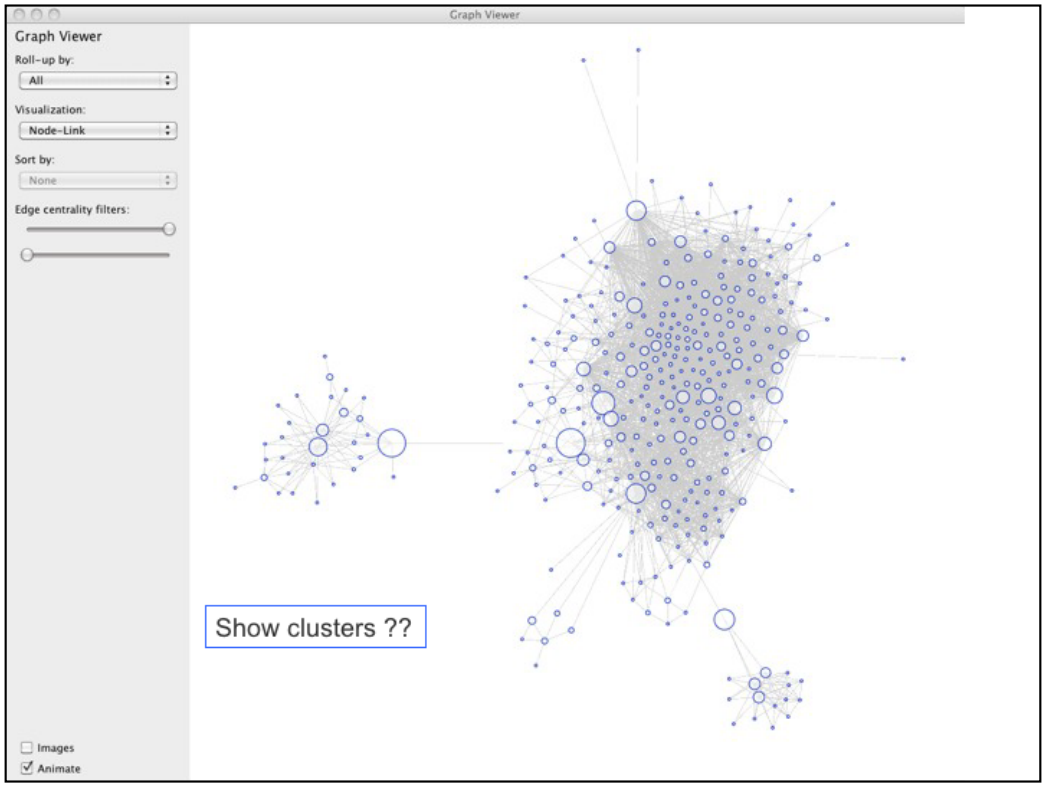
When should we not sort

Dynamic sorting

- Interactive example

  http://www.clearlyandsimply.com/clearly_and_simply/2011/11/dynamic-sorting-with-tableau.html



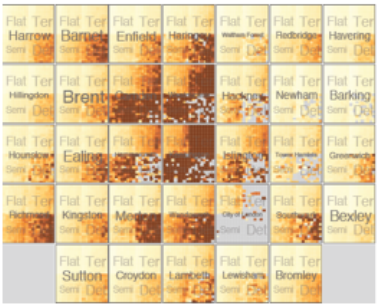

Graph Viewer
Graph Viewer
Roll-up by:
All
Visualization:
Node-Link
Sort by:
None
Edge centrality filters:
Images
Animate
Show clusters ??

Sorting to reveal structure (seriation)

J. Heer and B. Shneiderman. Interactiive Dynamics for Visual Analysis. ACM Queue, 2012..

Reconfigure: Change arrangement

- Show a different arrangement in same form



Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009)

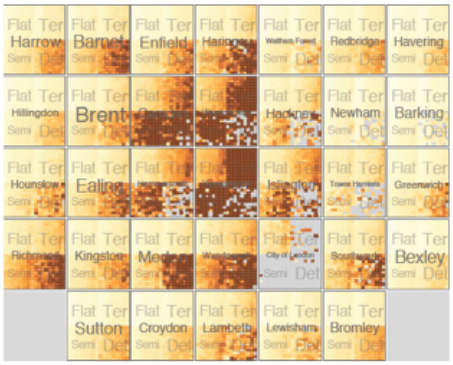
London Property example

Hierarchy

- House type – neighbourhood - sale time
- Colour → price variance
- Size → sales
- between neighborhoods: different house distributions
- within neighborhoods: see similar prices

Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009)

London Property example



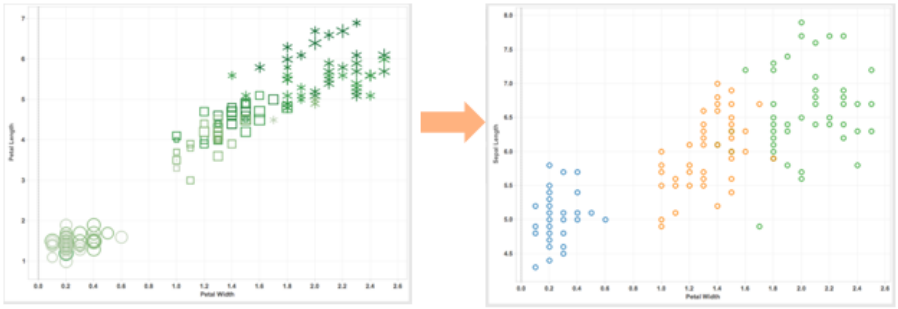
Hierarchy

- Neighborhood - house type - sale year - sale month.
- .Colour → avg price
- Size → fixed
- expensive neighborhoods near center

Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009)

Encoding: change visual variables

- Marks

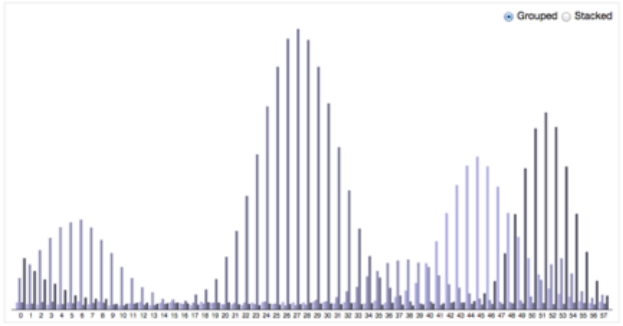


Encoding: change presentation (form)

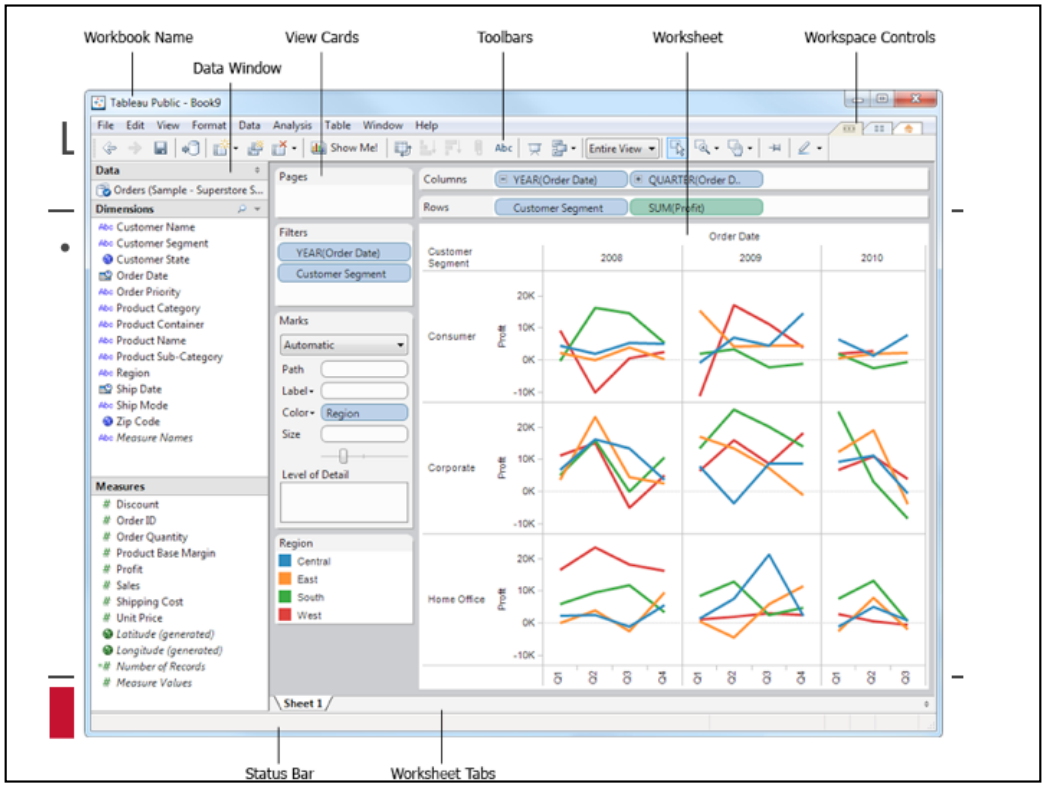
- Remember this?

Encoding: change presentation

- Transitions are important

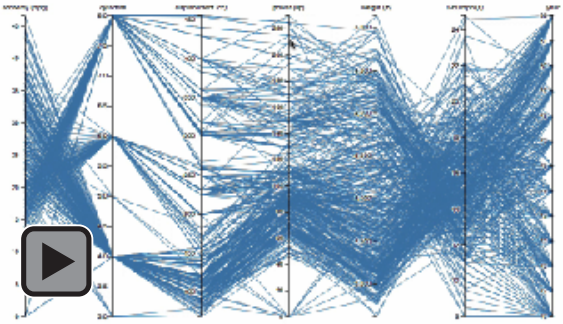


http://bl.ocks.org/mbostock/3943967

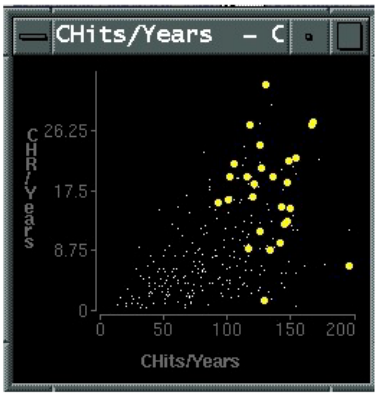

Workbook Name
View Cards
Toolbars
Worksheet
Workspace Controls
Data Window
Tableau Public - Book9
File Edit View Format Data Analysis Table Window Help
Show Me!
Entire View
Data
Orders (Sample - Superstore S...
Dimensions
Customer Name
Customer Segment
Customer State
Order Date
Order Priority
Product Category
Product Container
Product Name
Product Sub-Category
Region
Ship Date
Ship Mode
Zip Code
Measure Names
Measures
Discount
Order ID
Order Quantity
Product Base Margin
Profit
Sales
Shipping Cost
Unit Price
Latitude (generated)
Longitude (generated)
Number of Records
Measure Values
Pages
Filters
YEAR(Order Date)
Customer Segment
Marks
Automatic
Path
Label
Color
Region
Size
Level of Detail
Region
Central
East
South
West
Columns
YEAR(Order Date)
QUARTER(Order D..
Rows
Customer Segment
SUM(Profit)
Order Date
Customer Segment
2008
2009
2010
Consumer
Corporate
Home Office
Profit
20K
10K
0K
-10K
Sheet 1
Status Bar
Worksheet Tabs

Highlighting/ “Brushing”

- Direct attention to a data subset within a graph [Wills 95]



http://bl.ocks.org/jasondavies/raw/1341281/



http://www.ggobi.org/docs/parallel-coordinates/

Brushing can be applied by to highlight selection by:

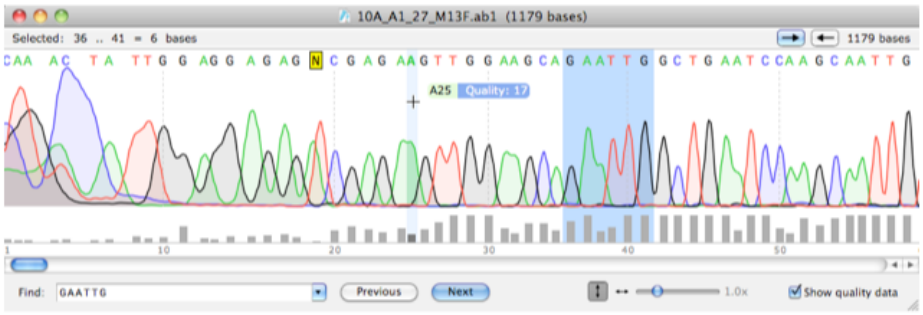
Direct interaction

Area interaction

Value interaction : data items that match some threshold.

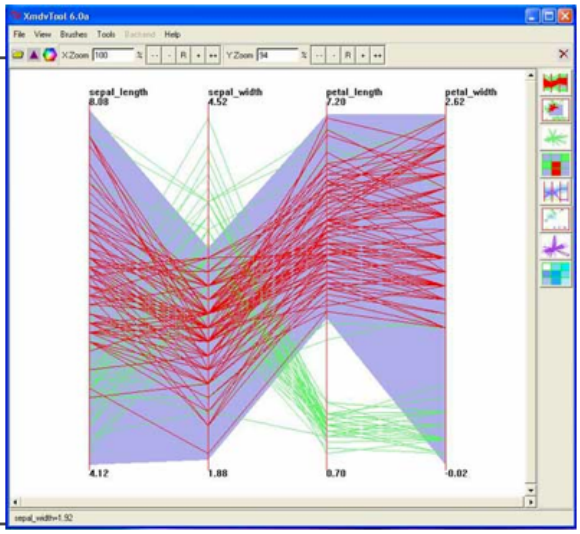
Play the video on the left to see an example of direct selection brushing. At the very end you will notice a particular varianf of brushing called “scrubbing”, where the area brush is rapidly moved around the data items.

Area brush, Annotation



http://www.snapgene.com/products/snapgene_viewer/

- Value brush
- Brushes can be combined



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With a value brush, some combination of attribute queries – data items that fit some threahold in the attribute specficied – can be highlighted. These brushes can be composited (overlaid), typically using colour, and subject to the same challenges that using colour generally presents.

Interaction for exploration

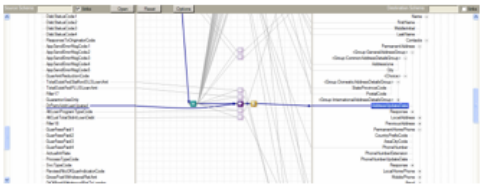
- Overcome limitations of display and memory capacity
  - Navigation
- Get more info about a case
  - zooming
  - Detail on demand
- Move aggregation view to individual view
  - Filter, reconfigure

https://www.ted.com/talks/gary_flake_is_pivot_a_turning_point_for_web_exploration#t-24588

Interaction is critical not only to moving around your data space but more fundamentally to exploration for discovery. We saw in this TED talk b Gary Flake how interaction fluidity is key to exploration and discovery.

Navigation

- Panning
  - Smooth movement of camera across scene (or scene moves and camera stays still)
- Scroll
  - (some subset of) view is moved horizontally or vertically
  - Bounded

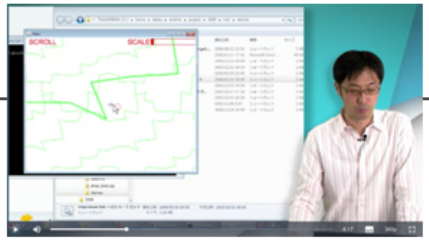


- Zoom
  - View enlarges/shrinks around central point
  - Pixels/detail gets larger/smaller

Zooming

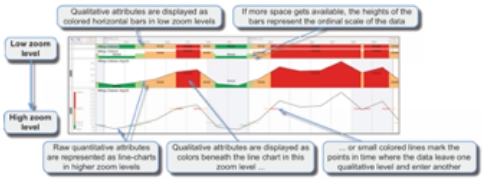
Intelligent Zooming

- Show semantically relevant information out of proportion
- Smart speed up and slow down
  - https://www.coursera.org/learn/interactive-computer-graphics/lecture/dDfiD/1-1-scrolling-interface



Semantic Zooming

- Zooming can be conceptual as opposed to simply reducing pixels



http://www.cvast.tuwien.ac.at/projects/semtimezoom

Geometric (standard) zooming:

The view depends on the “physical” /representational properties of what is being viewed

Semantic Zooming:

When zooming away, instead of seeing a scaled-down version of an object, see a different representation

The representation shown depends on the meaning to be imparted.

Filtering

- Extract data
- Selection
- Query

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[brushing] Highlight data of interest (and associate them across multiple views)

[filtering] remove or reduce the visual representation of unnecessary or spurious data

Not a binary operation, but a gradient of responses

Extract data of interest

Data can be selected by brushing values or specifying *queries*

Filter/Extract

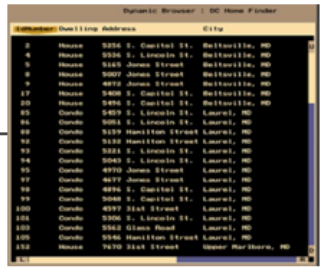
- Change the set of data cases being presented
  - Focusing
  - Narrowing/widening
- Simple filtering just removes all data not part of the selection.

Queries and filtering

A data query looks like:

SELECT house from seattle_homes
WHERE price <1000000 AND bedrooms > 2
ORDER BY price

SELECT name from cereals WHERE sugars < 4 and type = Health



Only shows exact matches !! Removes context ..

Don’t know magnitude of results

- Too few or too many hits!

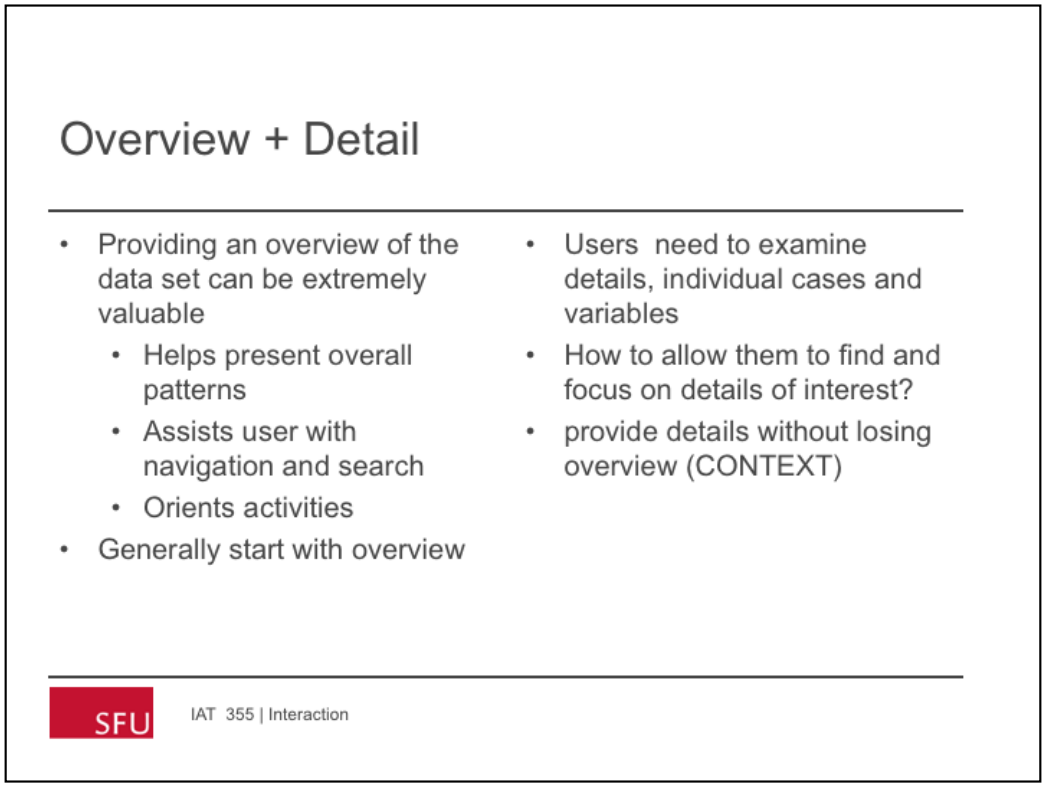
No helpful context is shown

No hint on how to reformulate the new query, and lose incremental results as you do

Reformulating to a new query can be slow

ZipDecode

http://benfry.com/zipdecode/



Allow viewer to examine cases and/or variables in detail while still maintaining context of those details in the larger whole

Concession

You simply can't show everything at once

Arrangement depends on what kinds of tasks and context you need to support

Overview + Detail

displays can be combined via either time or space

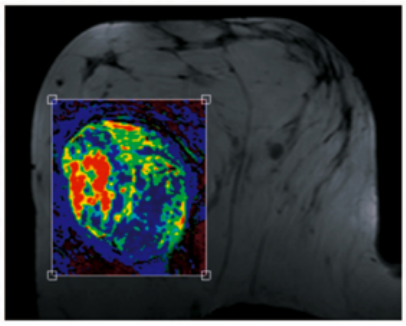
- Time - Alternate between overview and details sequentially in same place
  - Navigation (time)

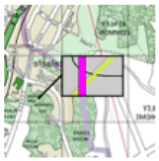
- Space - Use different portions of screen to show overview and details (View transformations)
  - Lenses
  - Details on demand

Single View

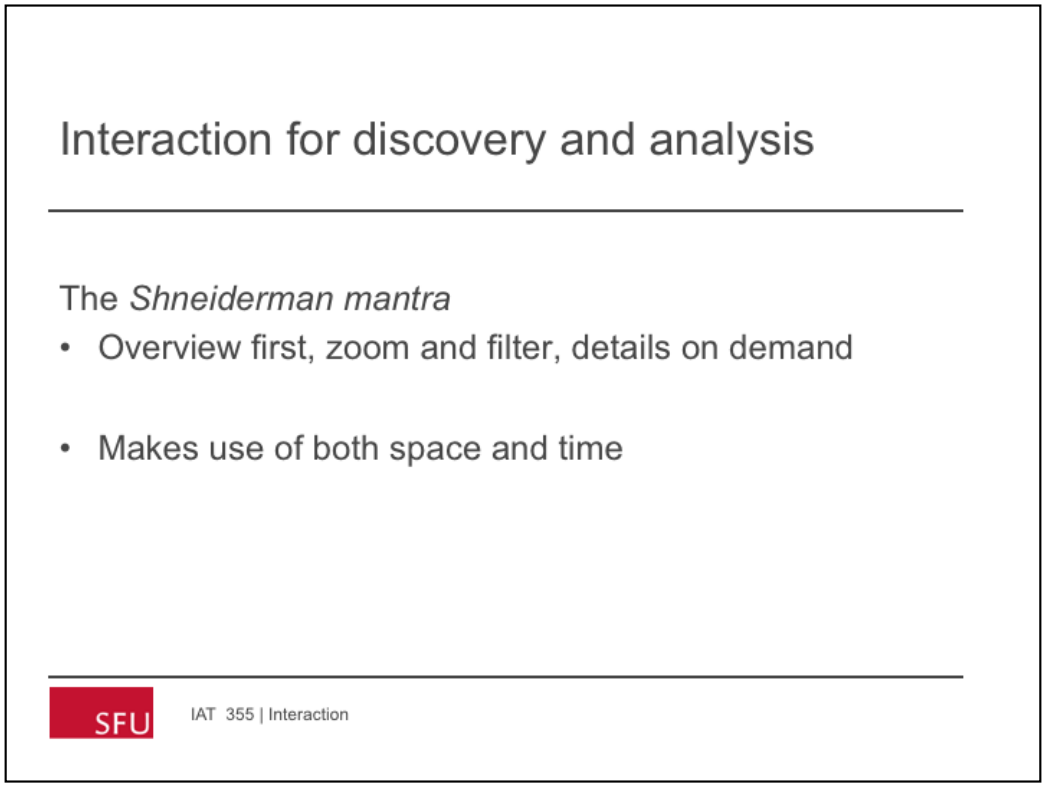
- Main + mini-map
- *Overview* or *Detail* gets the most space
  - Panning in one affects the other
- Could be extended to 3 or more levels
- Issue: How big are different views and where do they go?

Magic lens





Magic lenses are probes that give details of a region, revealing additional properties



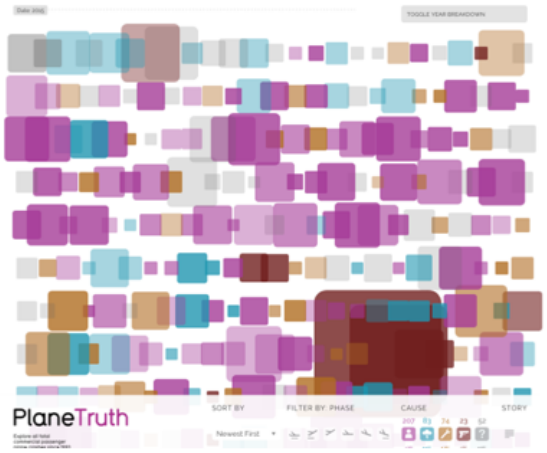
Limits contextual view of more information

May just be more info about a case

May be moving from aggregation view to individual view

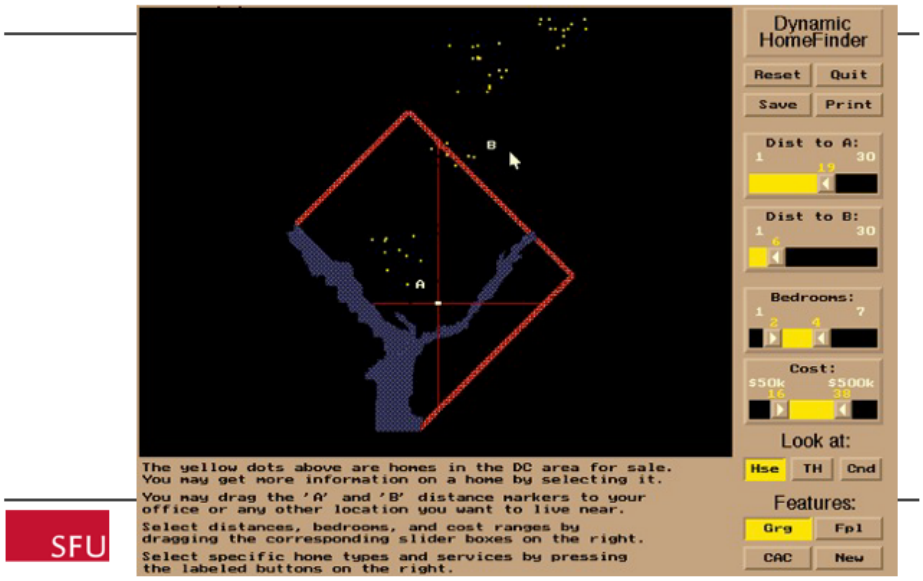
- May not be showing all the data due to scale problem
- May be showing some abstraction of groups of elements
- Expand set of data to show more details, perhaps individual cases

The Plane Truth



http://www.informationisbeautiful.net/visualizations/plane-truth-every-single-commercial-plane-crash-visualized/

Dynamic Queries [Williamson and Shneiderman 92]



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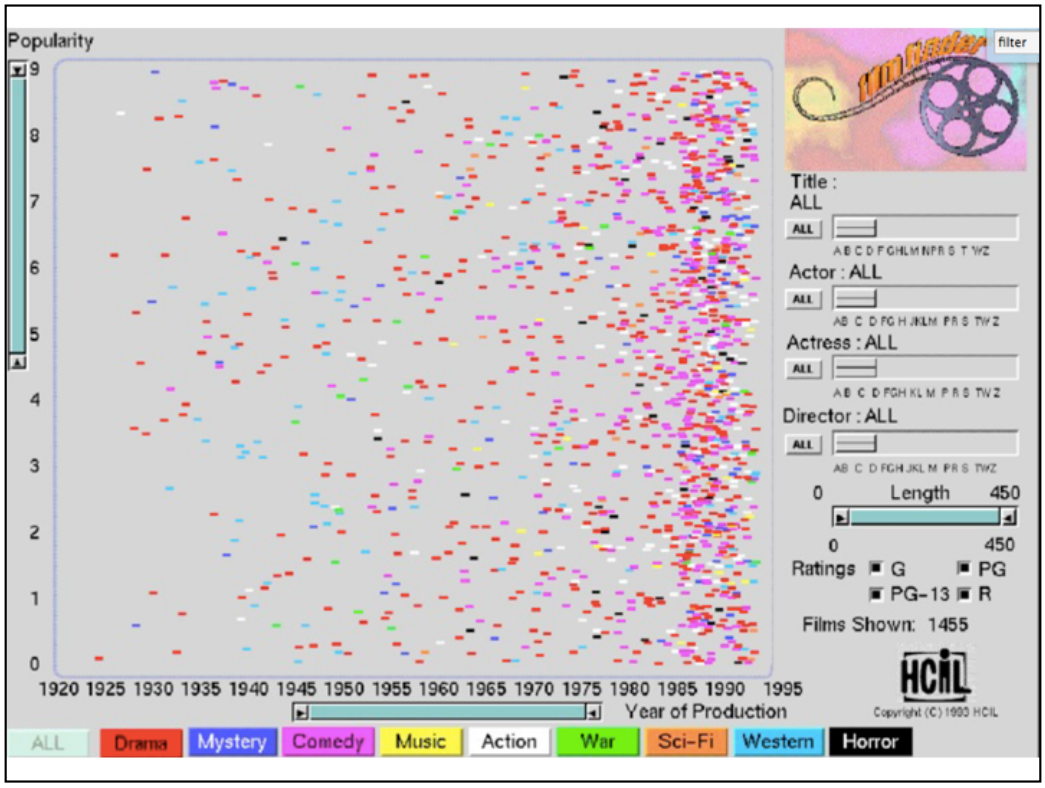
Specifying a query brings immediate display of results

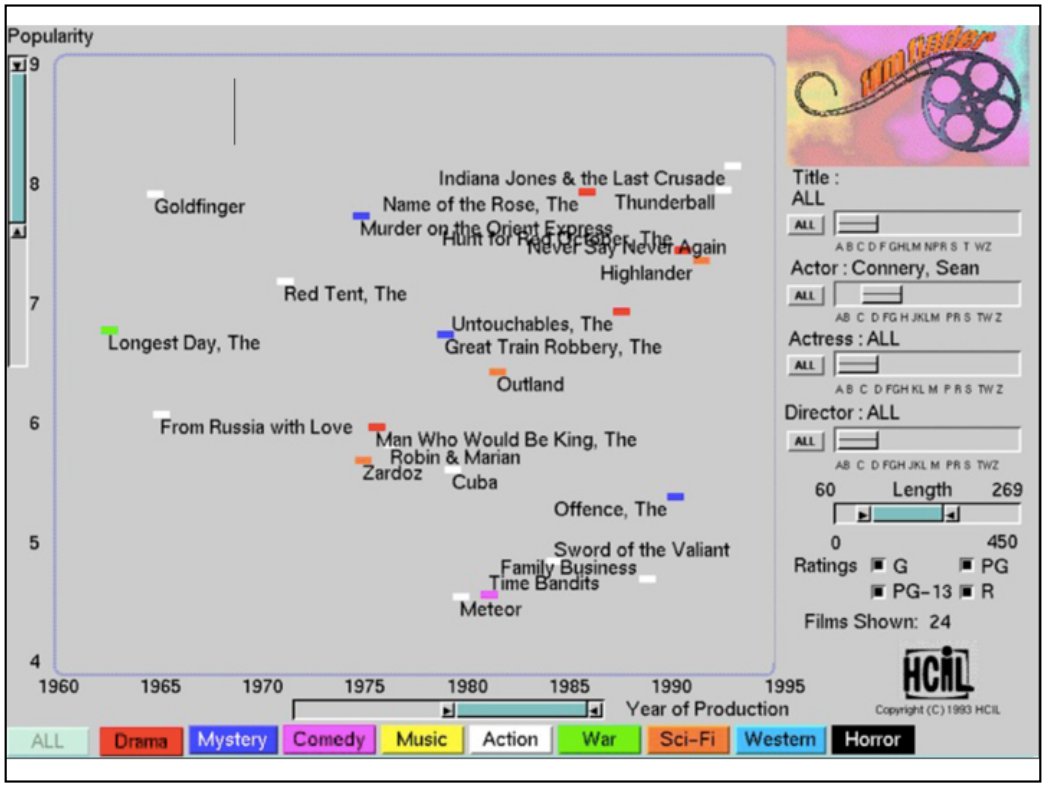
Responsive interaction (< .1 sec) with data, concurrent presentation of solution

“Fly through the data”, promote exploration, make it a much more “live” experience

Iterative, incremental and flexible query-response loop

Refinement is easy and manipulable


Popularity
9
8
7
6
5
4
3
2
1
0
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995
Year of Production
filter
Title :
ALL
Actor : ALL
Actress : ALL
Director : ALL
0
Length
450
0
450
Ratings
G
PG
PG-13
R
Films Shown: 1455
HCIL
Copyright (C) 1993 HCIL
ALL
Drama
Mystery
Comedy
Music
Action
War
Sci-Fi
Western
Horror


Popularity
9
8
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4
Indiana Jones & the Last Crusade
Goldfinger
Name of the Rose, The
Thunderball
Murder on the Orient Express
Never Say Never Again
Highlander
Red Tent, The
Untouchables, The
Longest Day, The
Great Train Robbery, The
Outland
From Russia with Love
Man Who Would Be King, The
Robin & Marian
Zardoz
Cuba
Offence, The
Sword of the Valiant
Family Business
Time Bandits
Meteor
1960
1965
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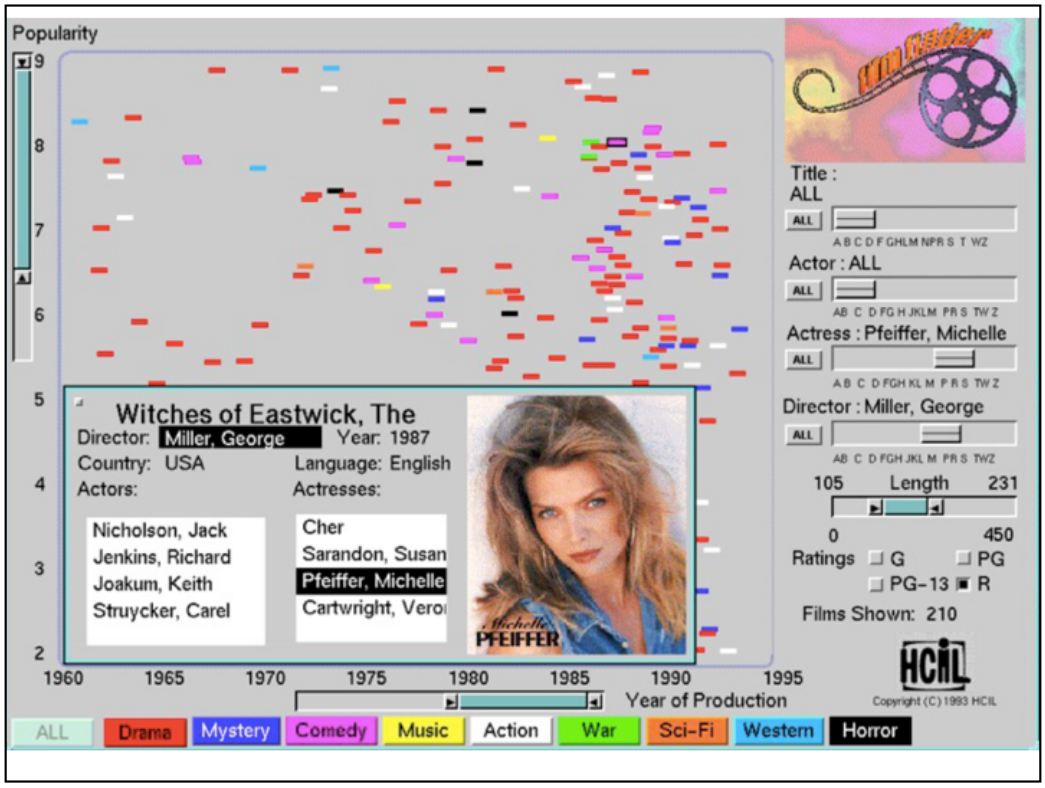
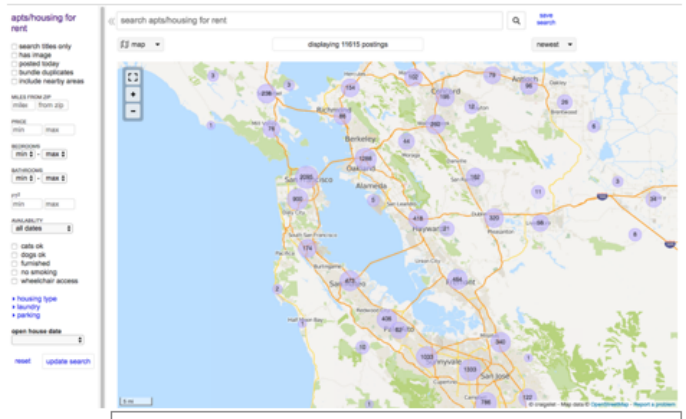
Year of Production
Title :
ALL
Actor : Connery, Sean
Actress : ALL
Director : ALL
60
Length
269
0
450
Ratings
G
PG
PG-13
R
Films Shown: 24
HCIL
Copyright (C) 1993 HCIL
ALL
Drama
Mystery
Comedy
Music
Action
War
Sci-Fi
Western
Horror



DETAILS ON DEMAND

A more familiar example



Dynamic queries allow imperfect specifications.

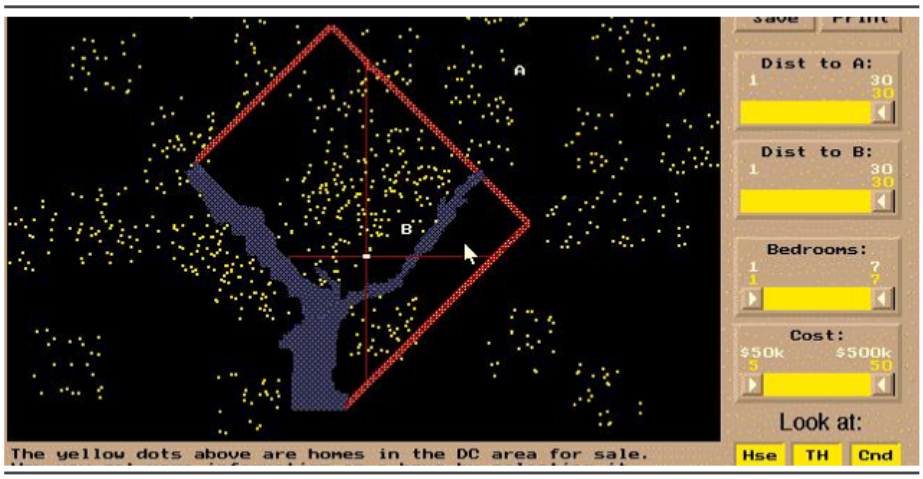
SFU

IAT 355 | Interaction

Imperfection is the Idea at the heart of the Dynamic Query technique.

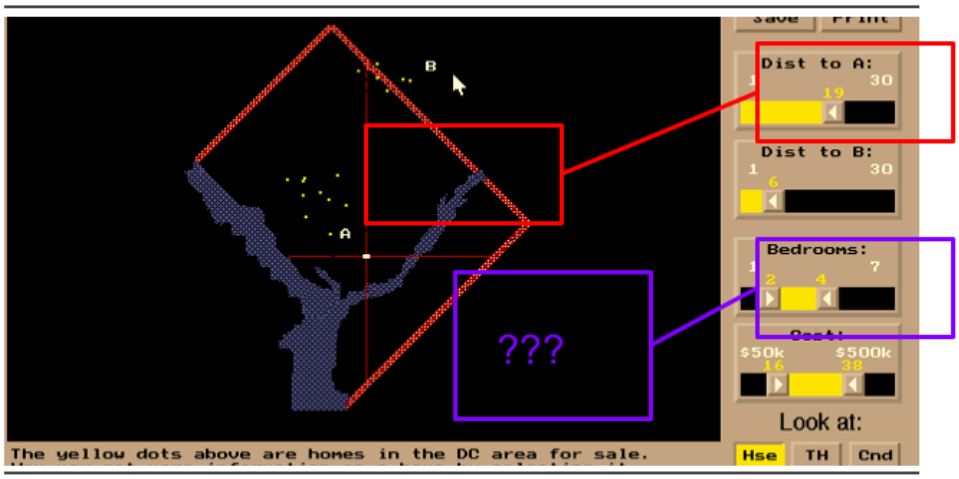
- There often simply isn't one perfect response to a query
- Want to understand a set of tradeoffs and choose some "best" compromise
- You may learn more about your problem as you explore

Dynamic Queries Revisited

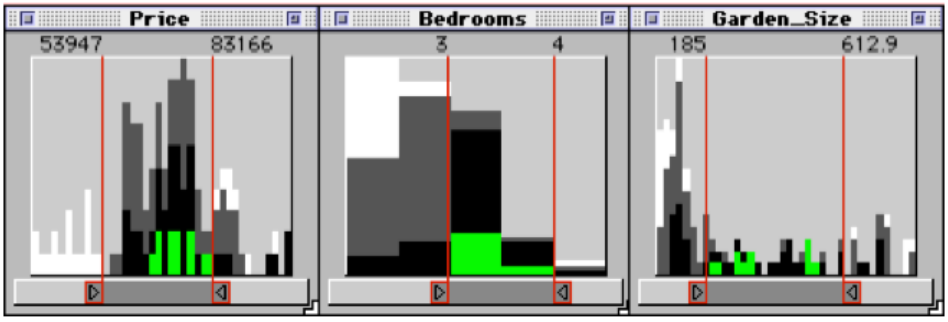


HomeFinder (Williamson and Shneiderman, 1992)

Sensitivity [Spence]

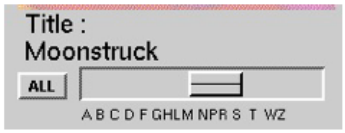


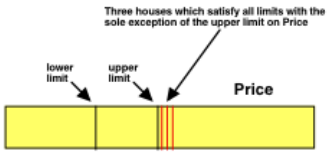
HomeFinder (Williamson and Shneiderman, 1992)

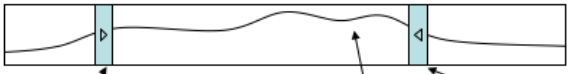


Black encoding of houses that fail one attribute limit provides ***sensitivity*** information

Data in controls





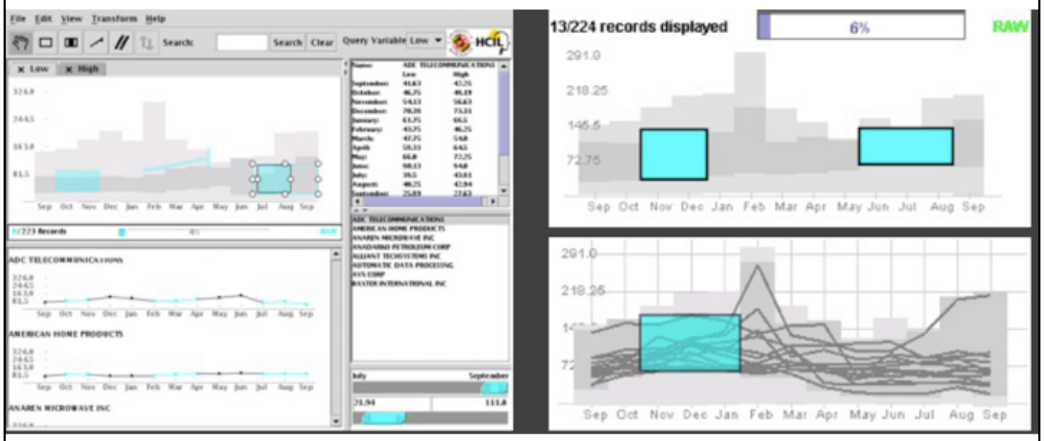


Lower Range Thumb

Data Distribution

Upper Range Thumb

TimeSearcher [Hochheiser and Shneiderman 02]

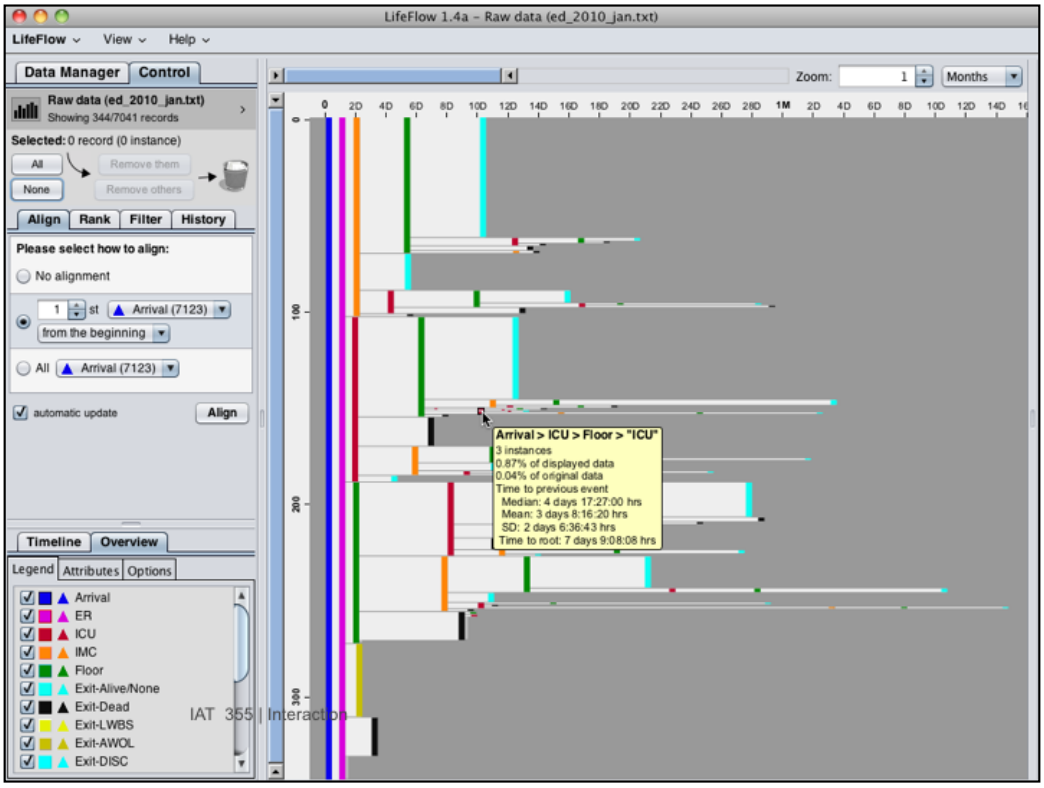


Visual representation of world of action including both the objects and actions

Rapid, incremental and reversible actions

Selection by pointing (not typing)

Immediate and continuous display of results



After removing all the common cases, we have 344 patients left.

These are mostly the patients who were admitted.

There are many information that I can explain from this visualization here, but I will go straight into the case that our physician partners are mostly interested in.

The mouse is pointing at this sequence, which represents the “bounce backs” patients, meaning patients who were transferred from ICU to Floor because they seemed to get better, however, they were transferred back to the ICU.

So the physician are interested in finding these patients to analyze what made them made the wrong decisions.

*optional

Another case is the step ups, which means the patients whose level of care were escalated to higher level, you can see from the visualization that there were patients who were transferred from ER to Floor (green) to ICU (red) and IMC (orange).

The number of these patients and the average transferred time could be compare to the hospital standards to measure the quality of care.

Interaction is not simple

- Composite tasks and questions
- Intent of task is critical
  - Search ?
  - Explore?
  - Analyse?
  - Investigate and compare?
  - Quick glimpse for overall synthesis?
  - …
- Extra interaction may be required
- Exploratory
  - Circuit designer investigating how design parameters contribute to performance aspects
- Seeking
  - Navigation through a space, categorically-driven filtering
- Opportunistic
  - "what's there?" defining space of opportunities
- Involuntary/ambient
  - Information appears and may trigger response

Summary

- Most visualizations are interactive
- Good visualizations are task dependent
  - Pick the right interaction techniques

Fundamental interaction tasks

- Encode (visualize), Arrange, Extract, Derive New, highlight, query explore, Coordinate and organize views

Techniques

- Extract, sort, annotate, layout, choose view, dynamic queries, brushing, filter, sensitivity