



ARTS1422 Data Visualization

Lecture 12

Interactions in Visualization

Quan Li
Spring 2024
2024.04.11

Once Upon A Time

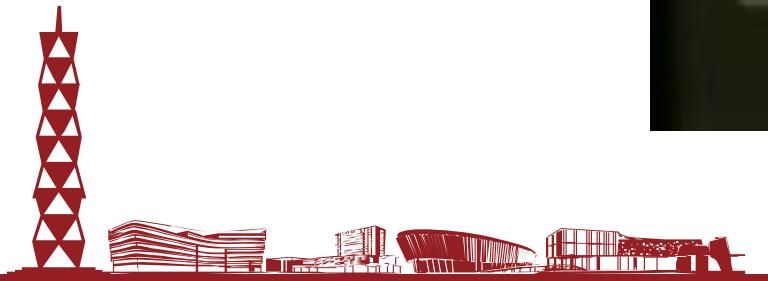


上海科技大学
ShanghaiTech University

Sketchpad Ivan Sutherland 1963



<https://www.youtube.com/watch?v=5RyU50qbvzQ>



立志成才报国裕民

Interactions in Visualization

“Overview first, zoom and filter, and details on demand.”

-Ben Schneiderman

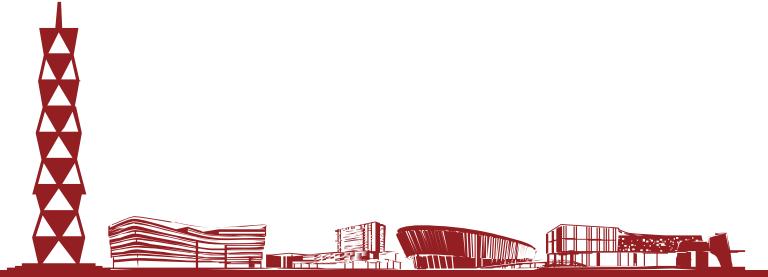


<http://www.cs.umd.edu/users/ben/>



OUTLINE

- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design





OUTLINE

- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design

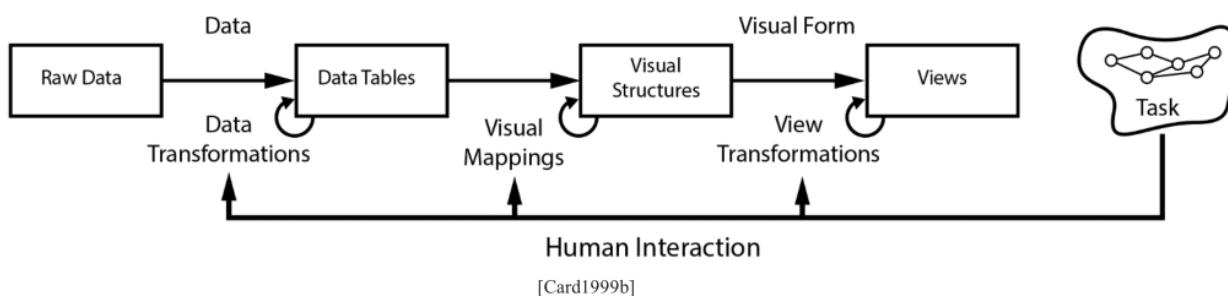
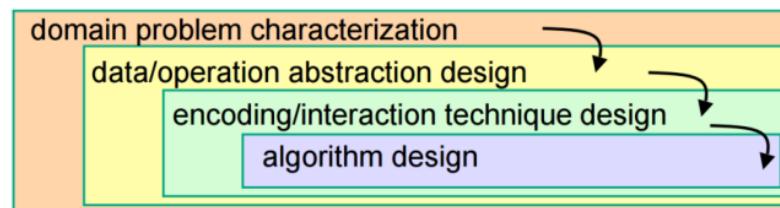
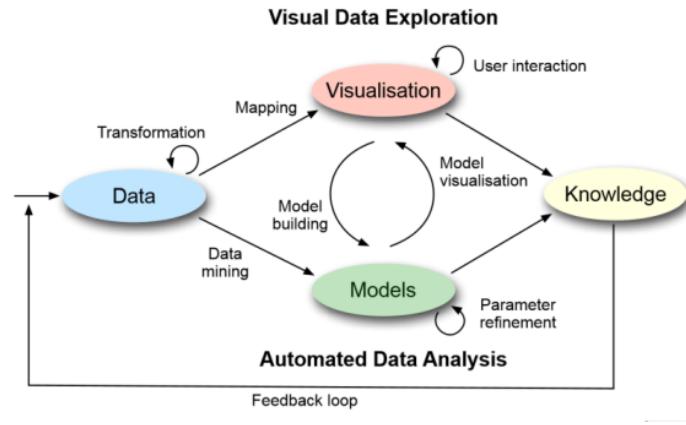


Representation and Interaction

There are two major components of information visualization:

- **Representation** of objects users pay attention to, and
- **Interactions** which are operations users can apply.

Interactions in Visualization



Types of Interactions

Dix and Ellis (AVI 1998)

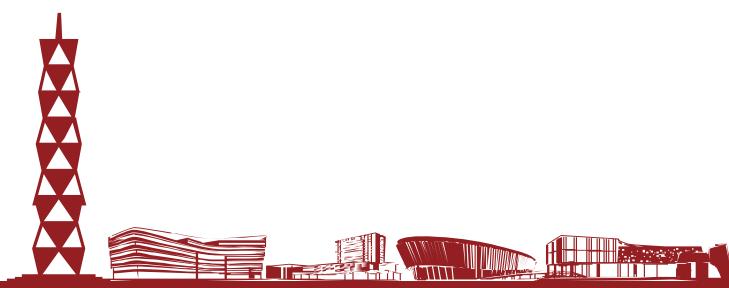
- Highlighting and focus
- Accessing extra info – drill down and hyperlinks
- Overview and context – zooming and fisheyes
- Same representation, changing parameters
- Linking representations – temporal fusion

Daniel Keim (TVCG 2002)

- Projection
- Filtering
- Zooming
- Distortion
- Brushing & linking

Yi et al. (TVCG 2007)

- Select
- Explore
- Reconfigure
- Encode
- Abstract/Elaborate
- Filter
- Connect



A close-up photograph of a DNA microarray slide, showing a grid of small, dark spots on a light background, representing individual genes or DNA samples.

Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect



Select

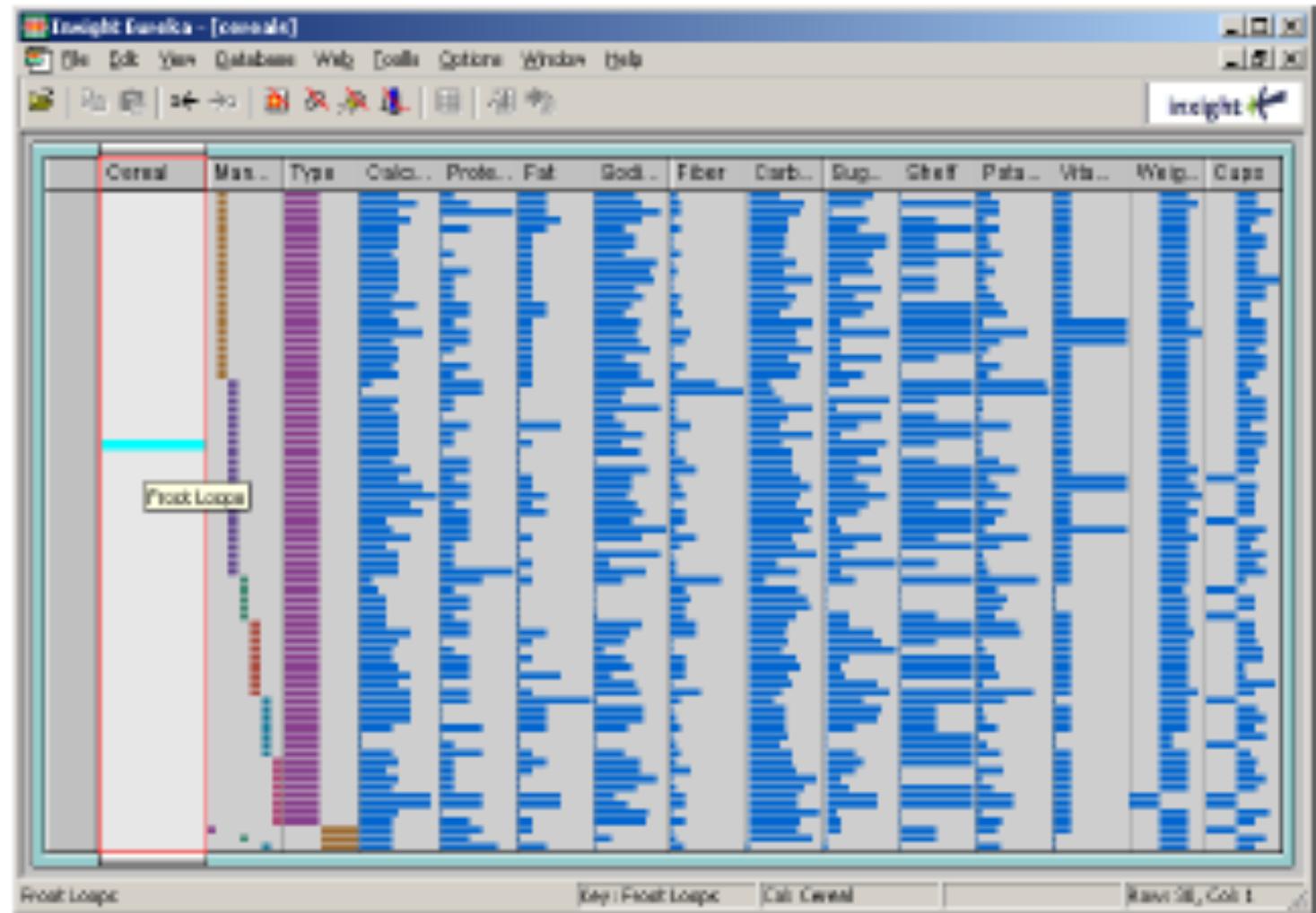
- “Mark something as interesting.”
- Mark items of interest to keep track.
- Seems to often work as a preceding action to subsequent operations.

Examples

- Select a landmark in Google Map.
- Select the Focus feature in TableLens.

Method 1: Pop-up Tooltips

Hovering mouse cursor
brings up details of item.





Method 1: Pop-up Tooltips

Hovering mouse cursor brings up details of item.

SIMPLE TOOLTIPS

2 years ago | 20 Replies

Easily add tooltips to your WordPress site. Tooltips will show when target element is hovered over. On mobile devices tooltips show when target element is tapped. You can easily pick your tooltip color settings in **Settings > Simple Tooltips**.

Now you know what it will look like

What Will it Look Like?

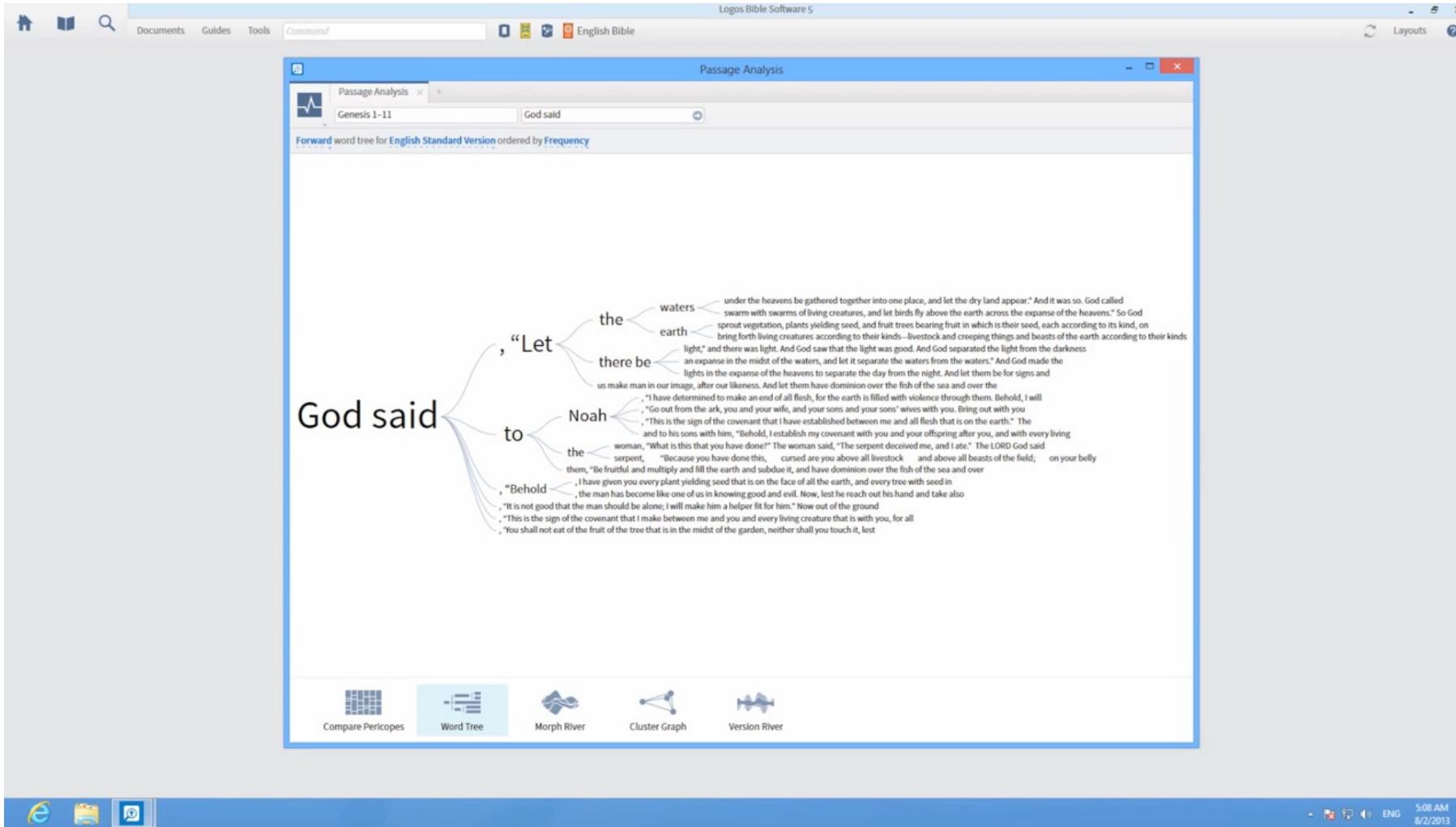
To see an example hover over this text. I'm using the plugin in many places on this site (for example, when you hover over the 'about me' picture in the top left of the page).

<https://wordpress.org/plugins/simple-tooltips/>

立志成才报国裕民

Method 1: Pop-up Tooltips

Hovering mouse cursor brings up details of item.

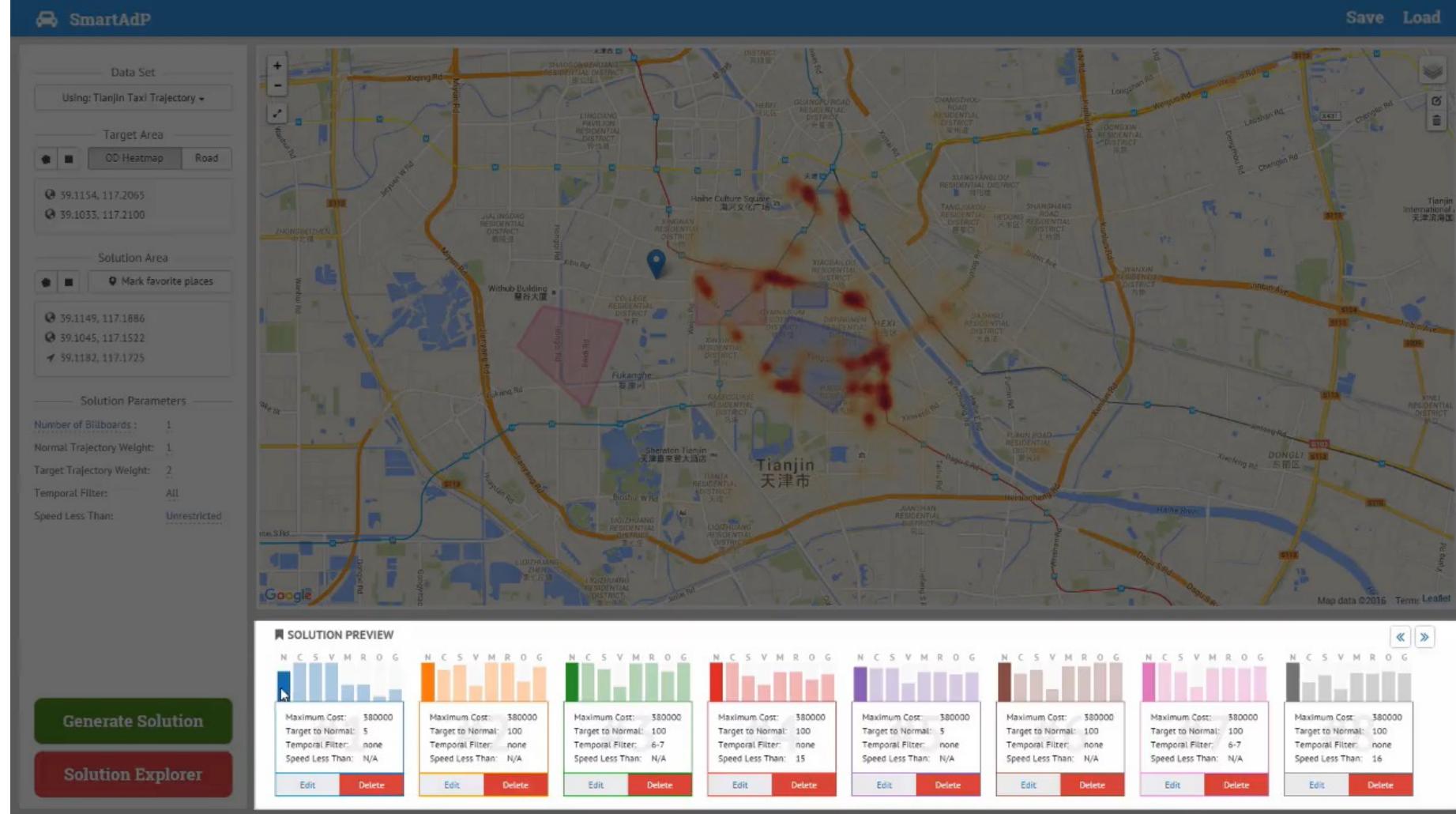


https://www.youtube.com/watch?v=-cV_dnzS9wo

立志成才报国裕民

Method 1: Pop-up Tooltips

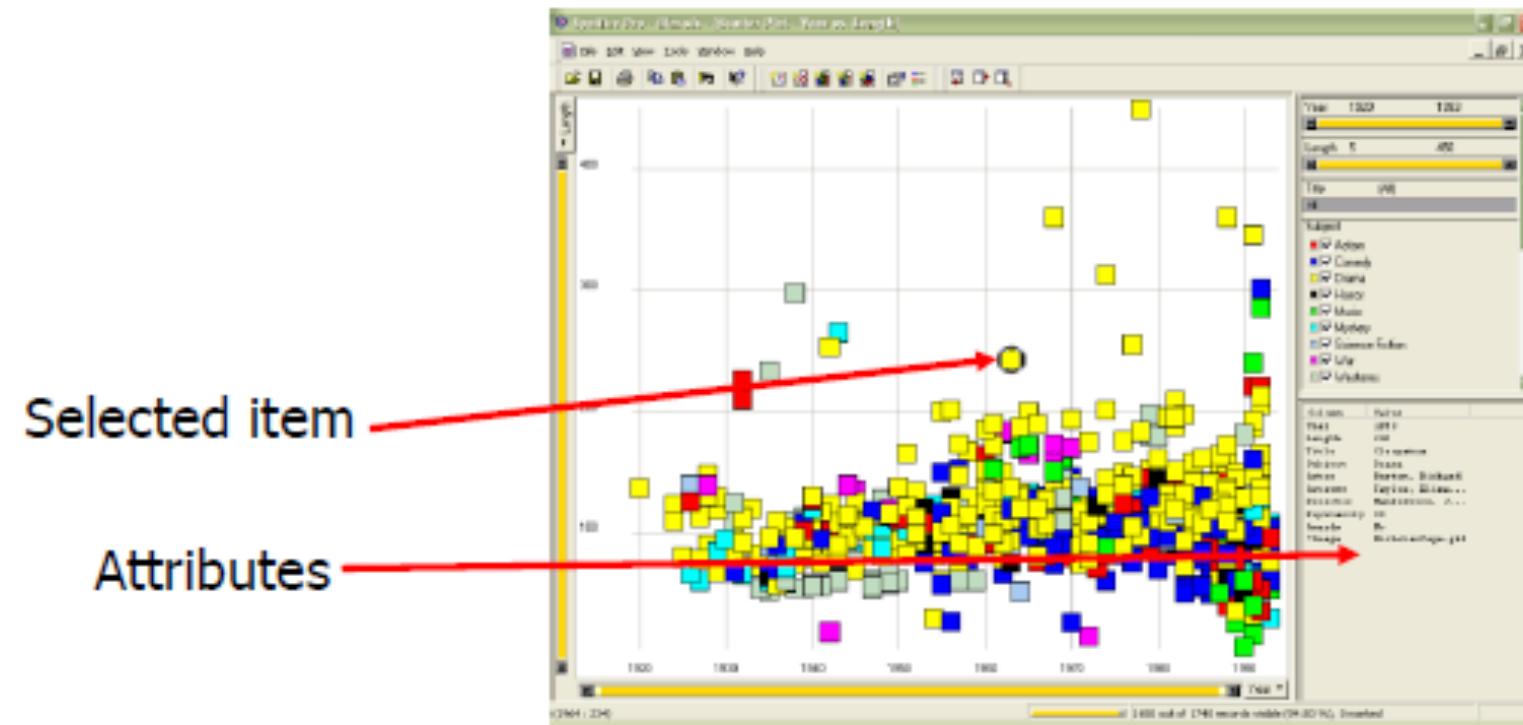
Hovering mouse cursor brings up details of item.



立志成才报国裕民

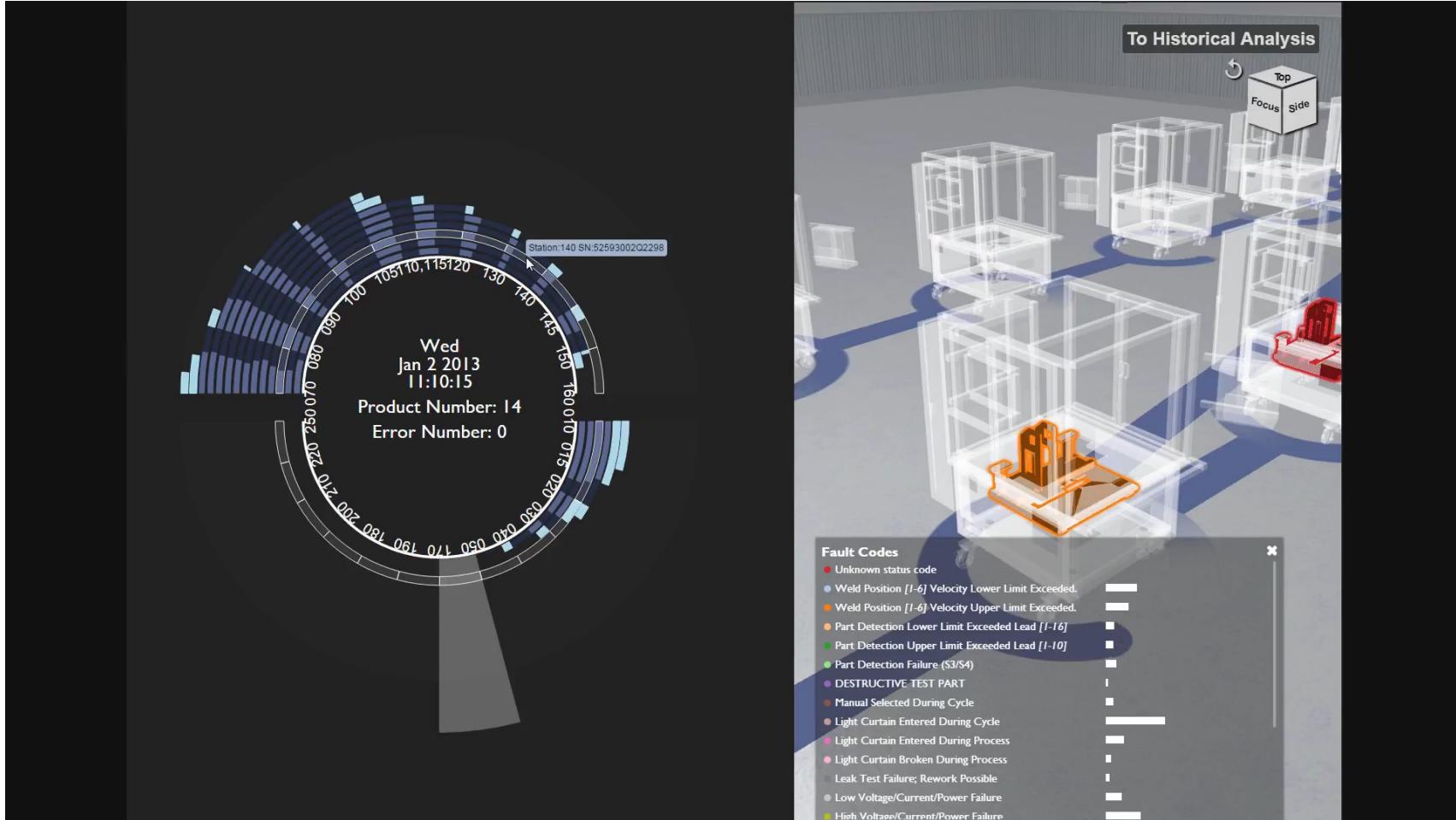
Method 2: Mouse Selection

Clicking on an item selects it and attributes of the data point are shown



Method 2: Mouse Selection

Click on an item, selects it and detail of the data are shown.



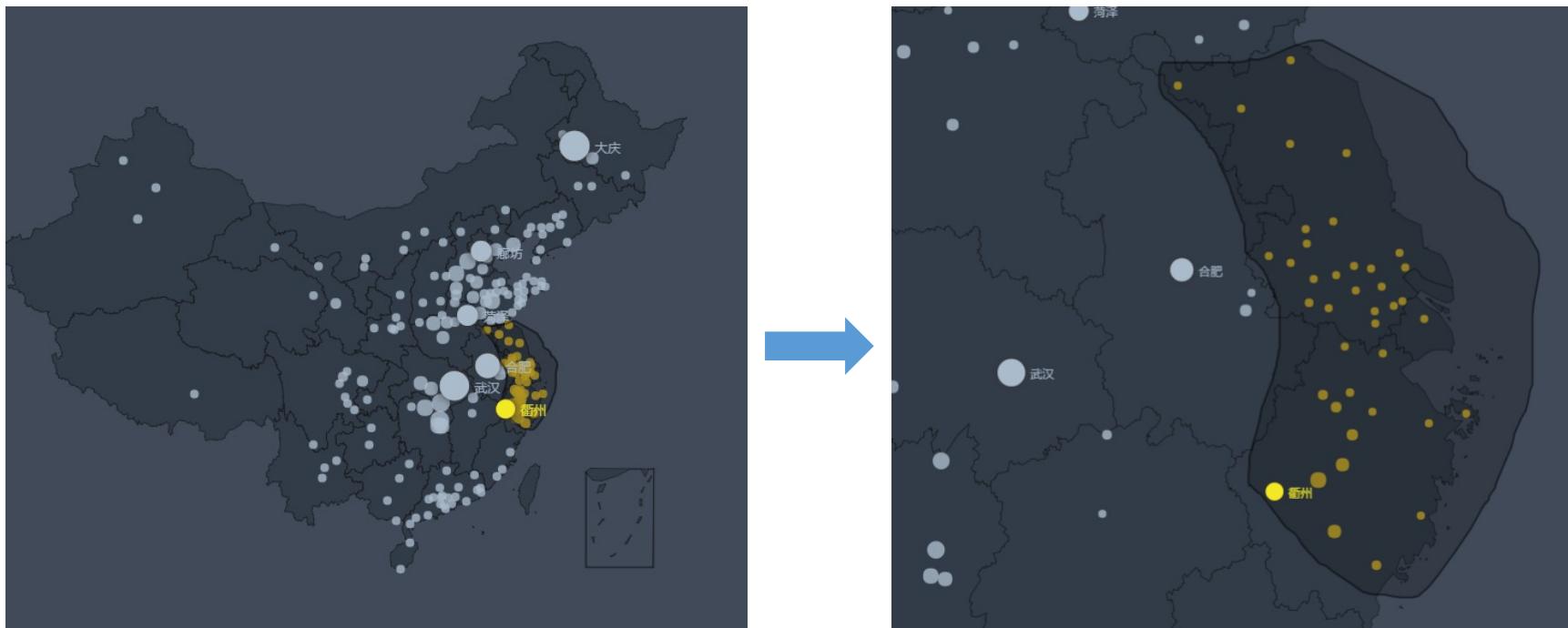
Xu et al. ViDX: Visual diagnostics of assembly line performance in smart factories. IEEE TVCG 2017

<https://www.youtube.com/watch?v=bjDzTtBbsLc>

立志成才报国裕民

Method 2: Mouse Selection

Select a region on the map and use amplification technology to visualize clusters in the selection.

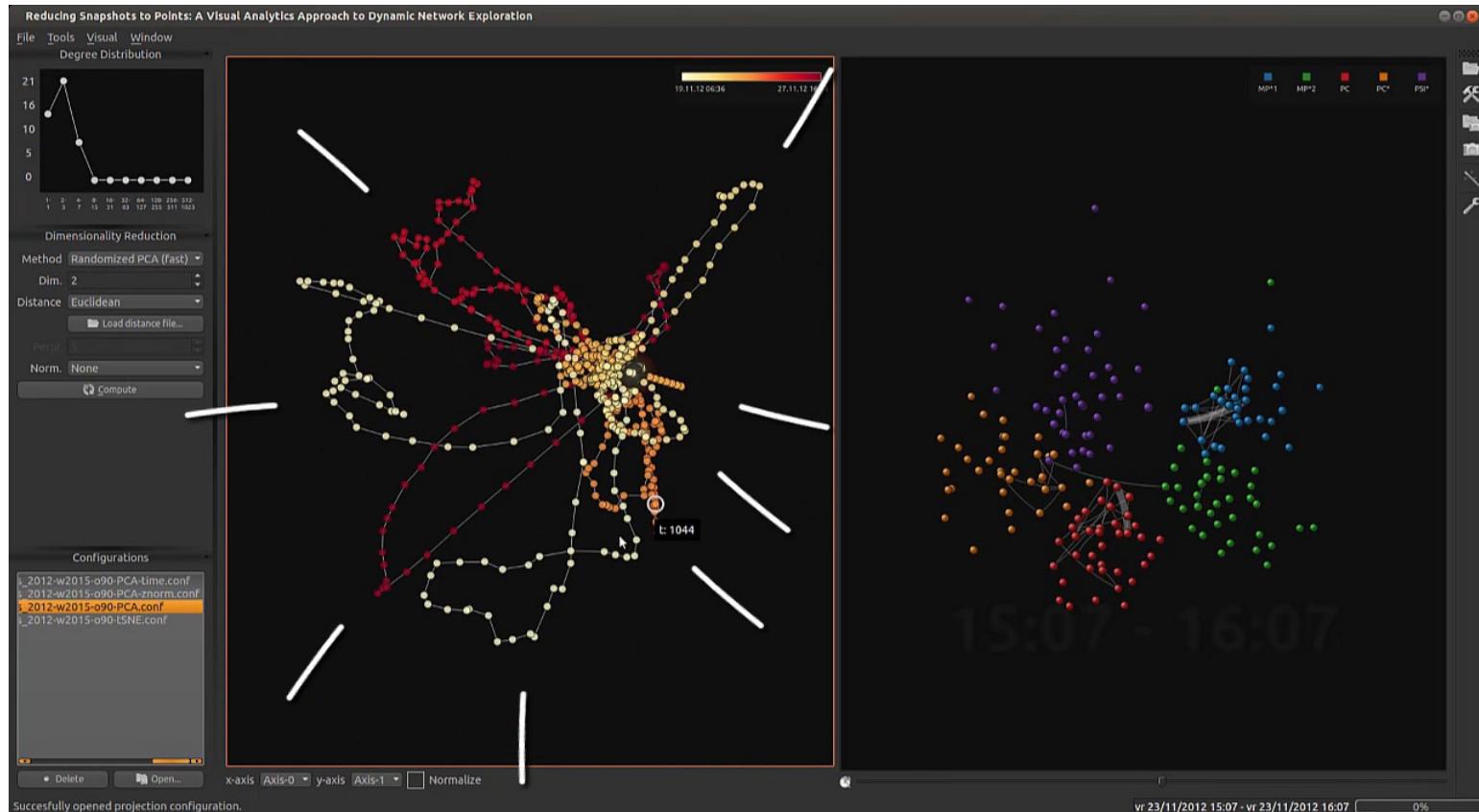


<http://www.echartsjs.com/examples/#chart-type-map>

立志成才报国裕民

Method 2: Mouse Selection

Select a region on the map and use amplification technology to visualize clusters in the selection.



Problems and Goals of Label Selection

Where are the labels?

- Labeling is difficult to do when so many entities exist.
- Can add to ball of string problem.

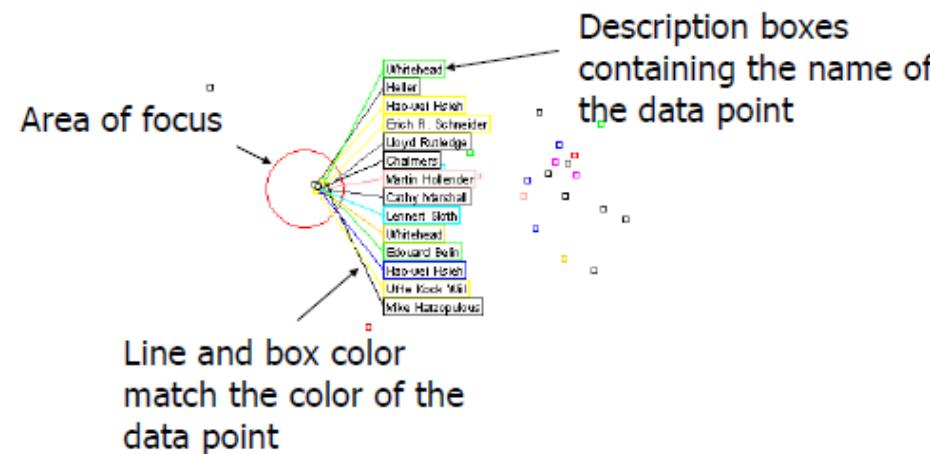
Each label for a data point should:

- Be readable,
- Non-ambiguously relate to its graphical object, and
- Not hide other pertinent information.

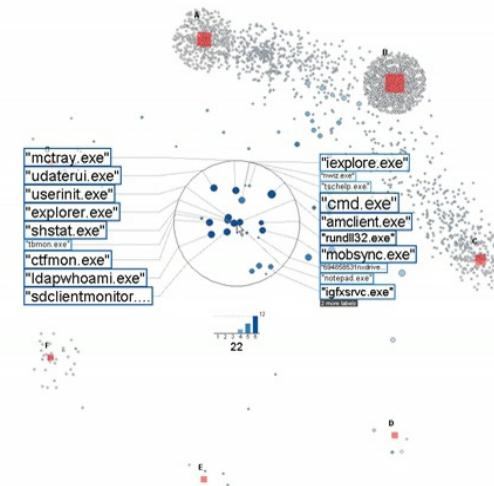
Completeness (labeling of all objects) is desired but not always possible.

Excentric Labeling

- “Invisible” – Do not appear until user hovers over data points.
- Describe data points using the name field.
- Visually connect labels with data points.
- Order labels to indicate graph position.



Fekete and Plaisant
CHI '99



Bertini et al. Extended excentric labeling. Computer Graphics Forum. 2009.
<https://vimeo.com/4661780>



Select

Explore

Reconfigure

Encode

Abstract/Elaborate

Filter

Connect

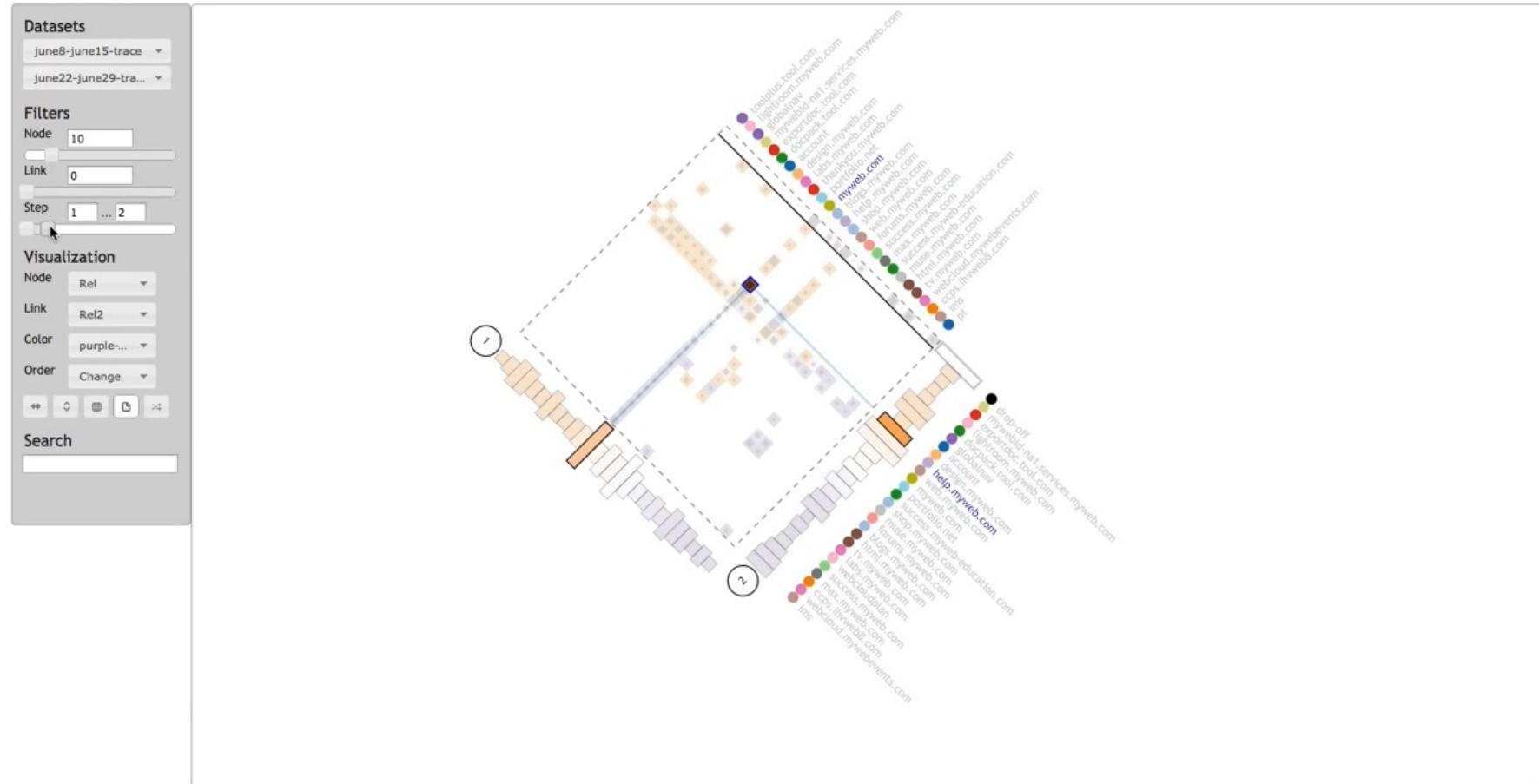


Explore

- “Show me something different.”
 - Exploration enable users to examine a different subset of data.
 - Exploration overcome the limitation of display size
- Examples
 - Panning in Google Earth
 - Direct Walking in Visual Thesaurus



2D Navigation



Zhao et al. MatrixWave: Visual comparison of event sequence data. ACM HFCS, 2015.
https://www.youtube.com/watch?v=HranxBG9F_w



3D Navigation



上海科技大学
ShanghaiTech University

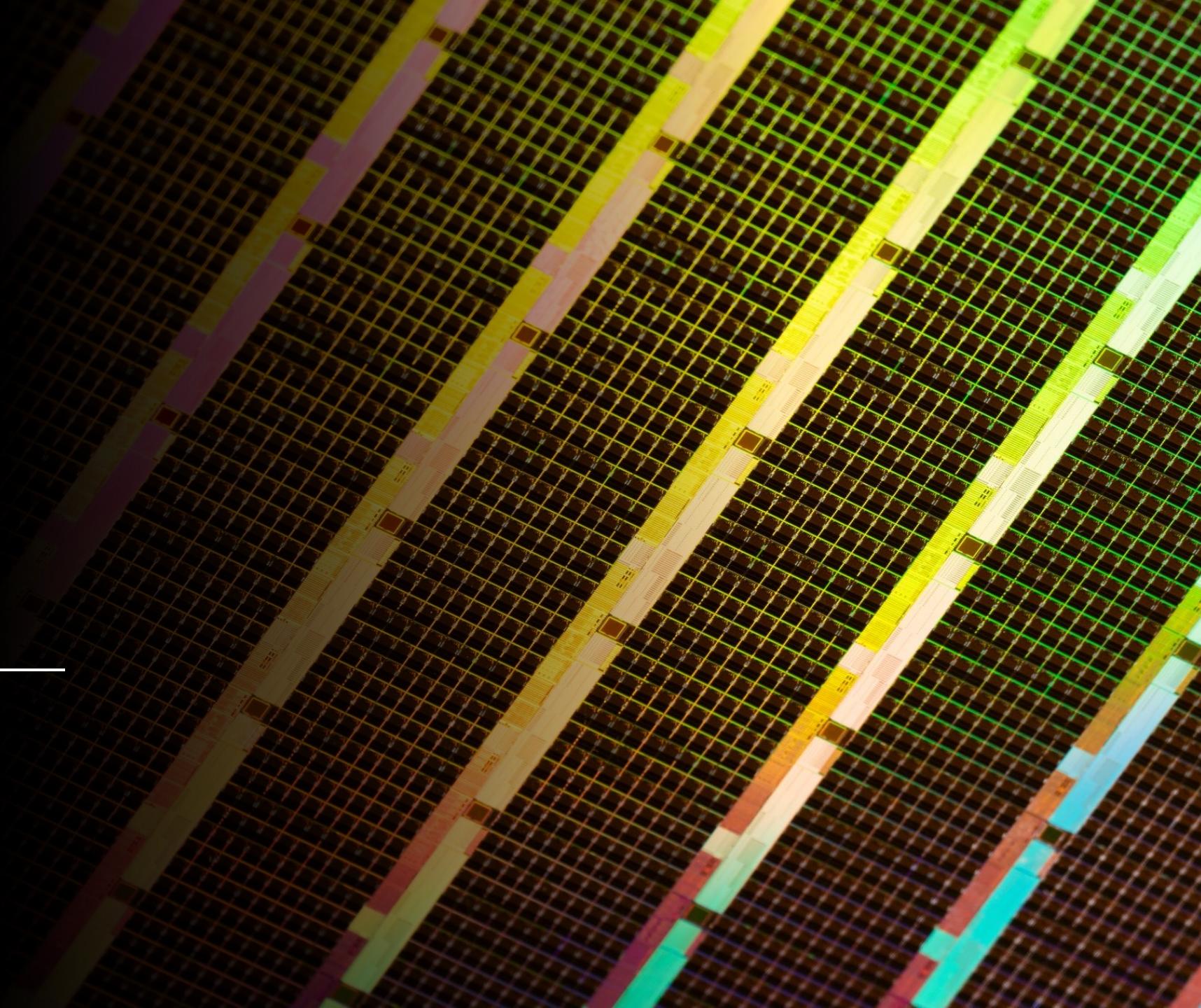


https://www.youtube.com/watch?v=tI_sJuA2LWg



立志成才报国裕民

Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect



Reconfigure

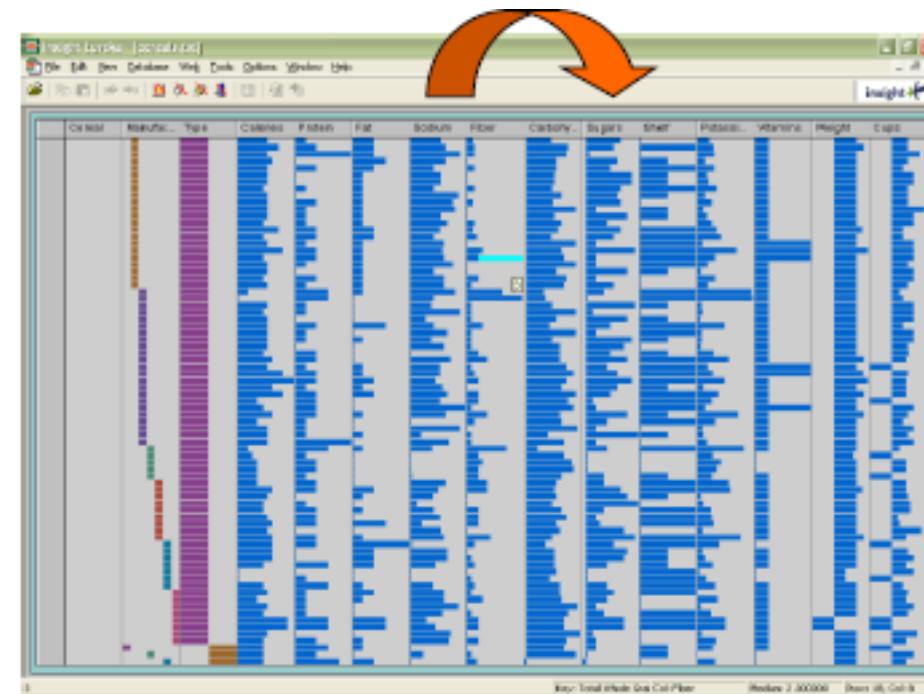
- “Show me a different arrangement.”
- Reconfiguring provides different perspectives by changing the spatial arrangement of representation.
- Examples
 - Sorting and rearranging columns in TableLens.
 - Changing the attributes in a scatter plot.
 - The baseline adjustment feature in Stacked Histogram.
 - The “Spread Dust” feature in Dust & Magnet.



Method 1: Rearrange View

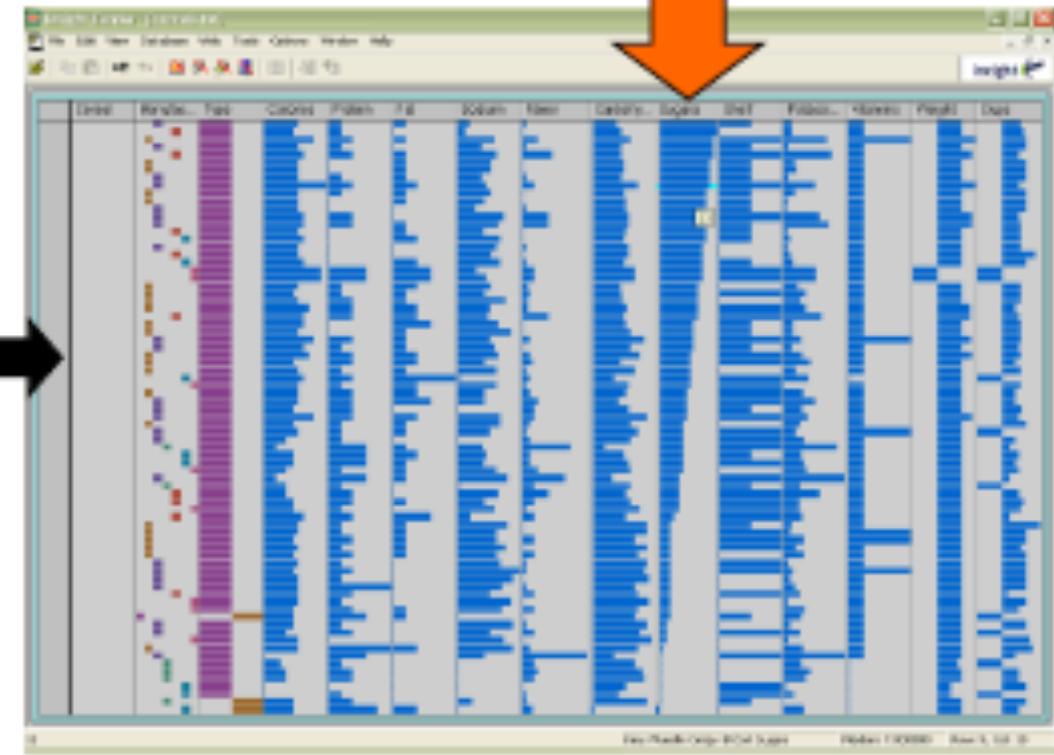
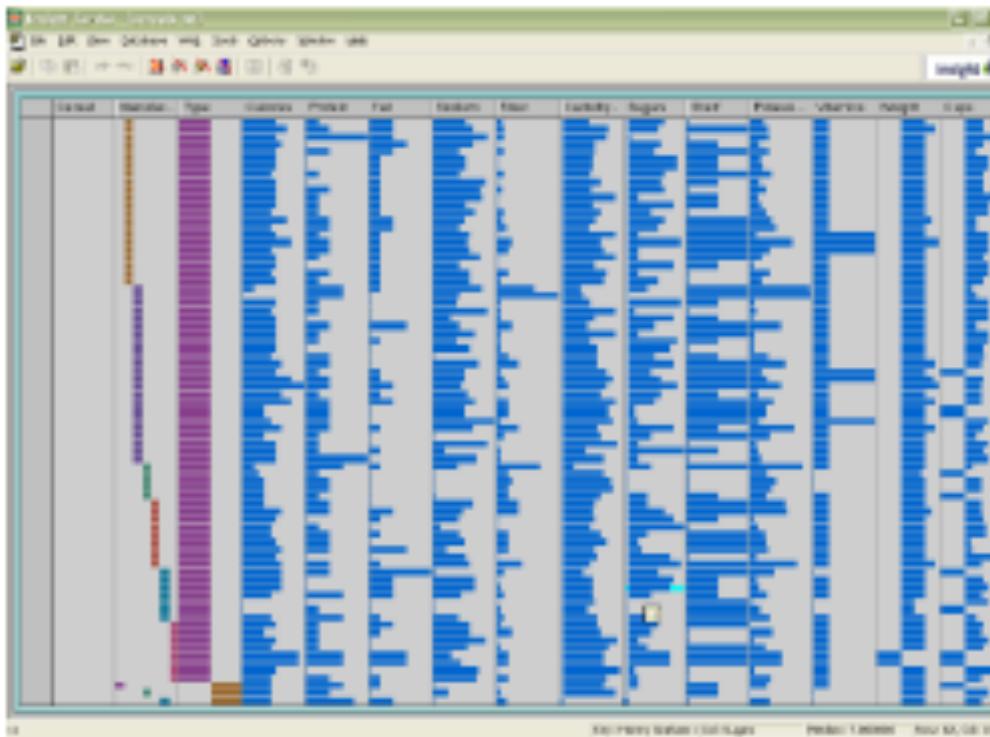
- Keep same fundamental representation and what data is being shown, but rearrange elements by:
 - Alter positioning
 - Sort

You can move columns
(attributes) left and right



Method 2: Sorting

- Sort data with respect to a particular attribute.



Method 2: Sorting

- Sort data with respect to a particular attribute.



Add Node

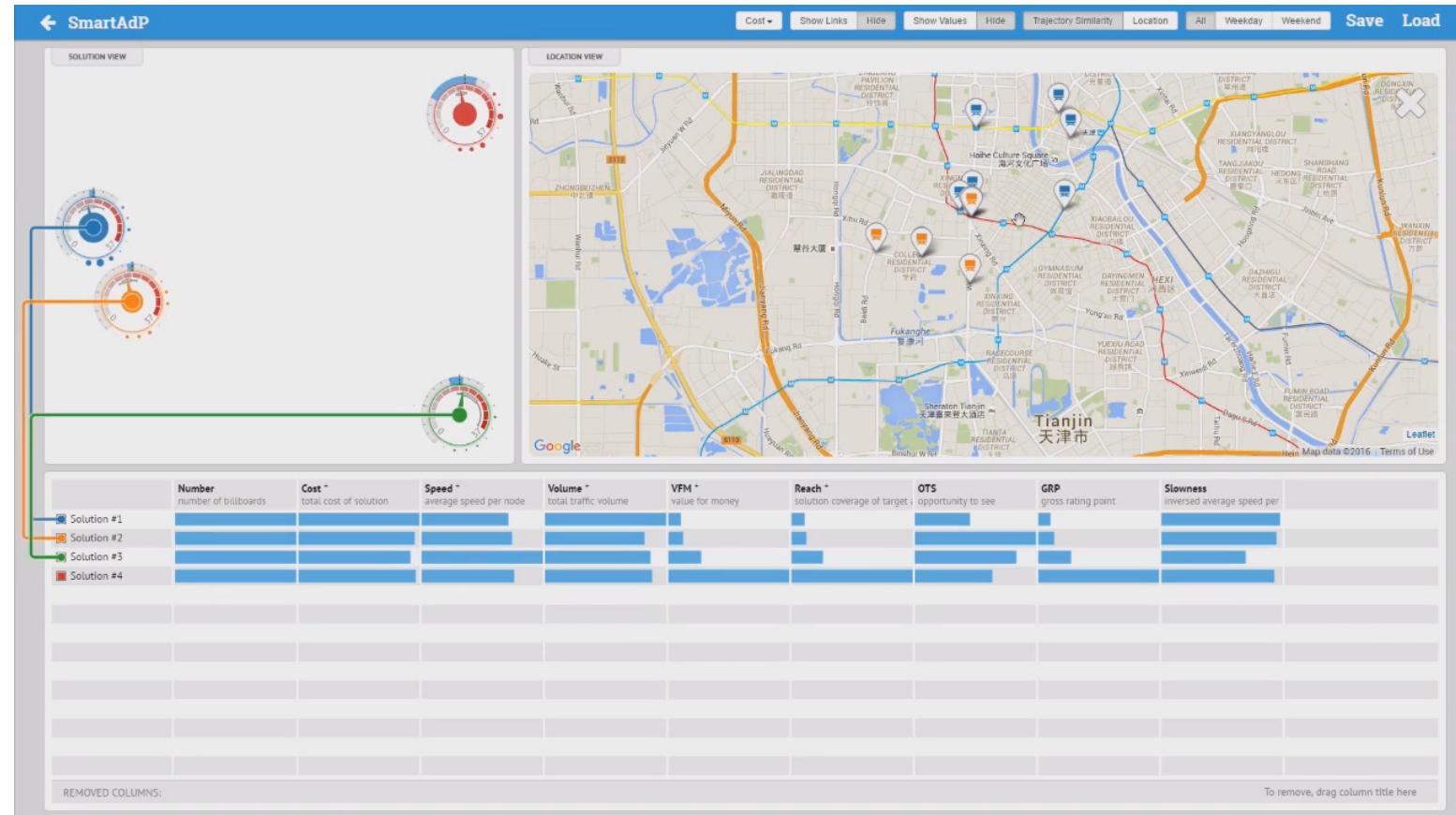
Nobre et al. Juniper: A Tree+ Table Approach to Multivariate Graph Visualization. arXiv 2018.
<https://www.youtube.com/watch?v=EAjNxFgsJ58>



立志成才报国裕民

Method 2: Sorting

- Sort data with respect to a particular attribute.

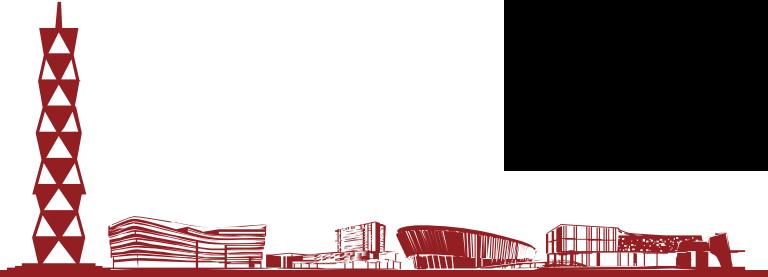
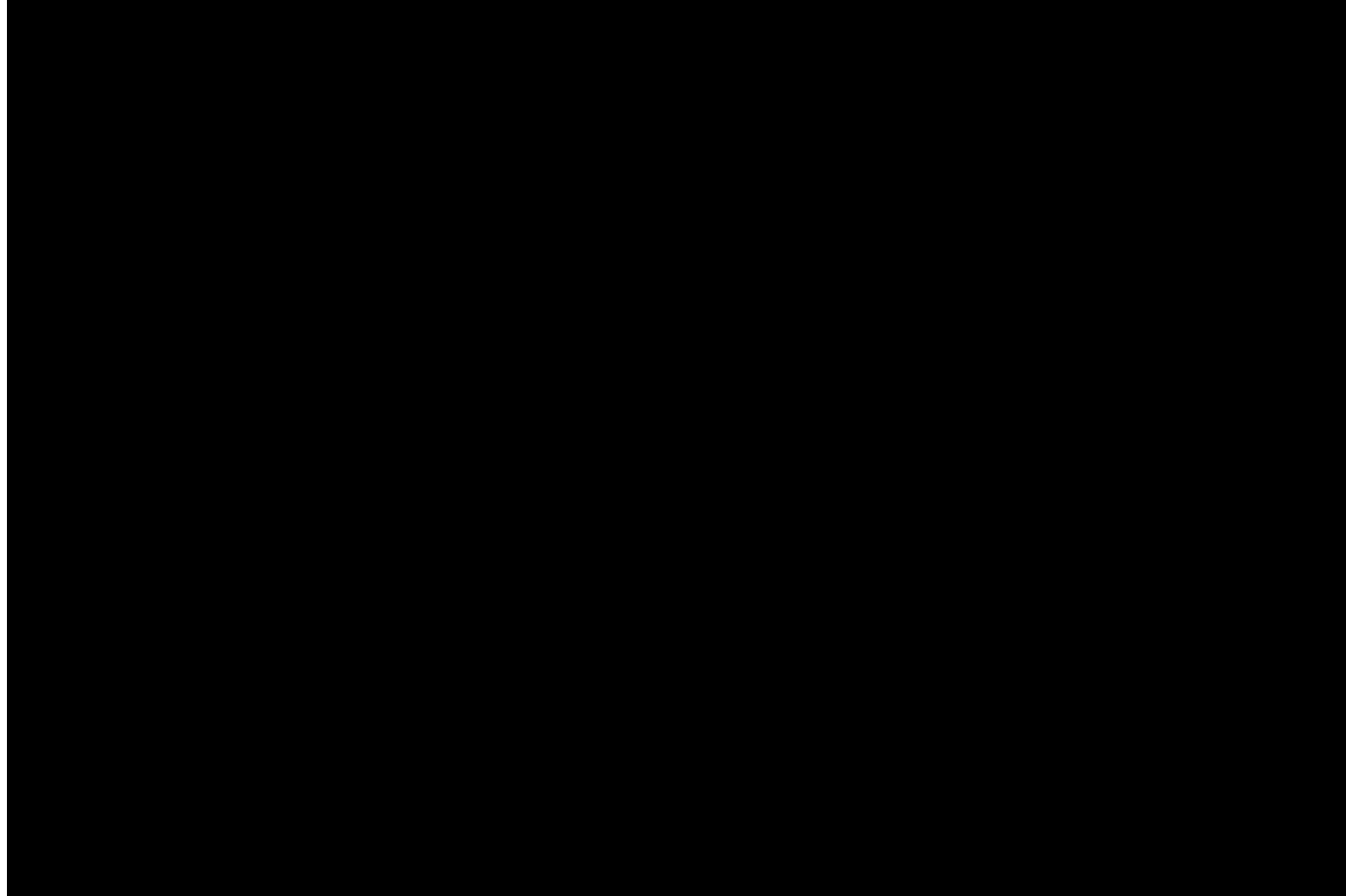


Liu, Dongyu, et al Smartadp: Visual analytics of large-scale taxi trajectories for selecting billboard locations. IEEE TVCG 2017
<https://www.youtube.com/watch?v=7vkYubflVuo>



Method 3: Reposition

- Dust & Magnet



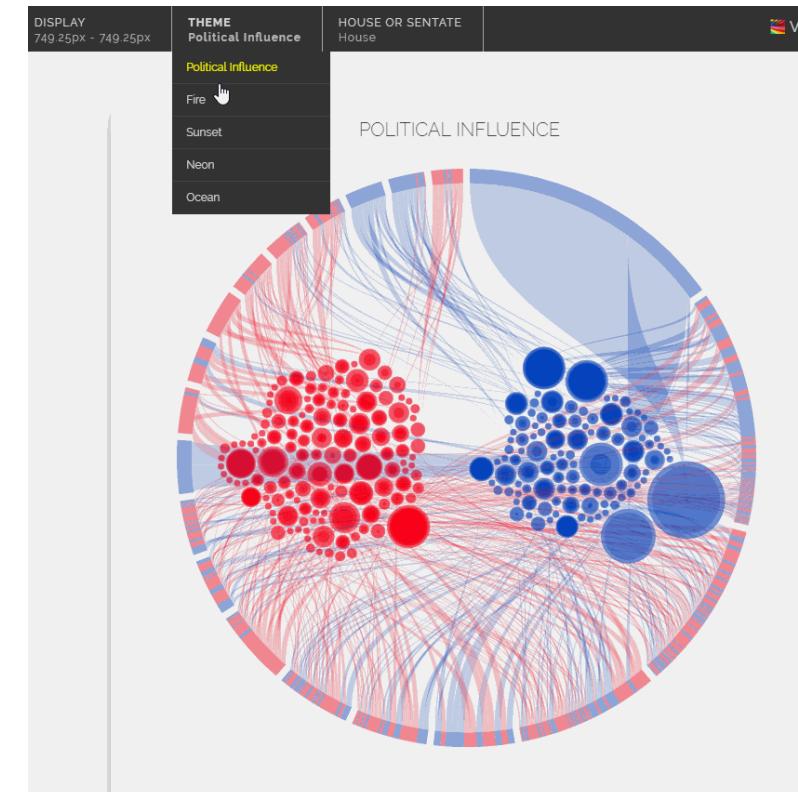


Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect

Encode



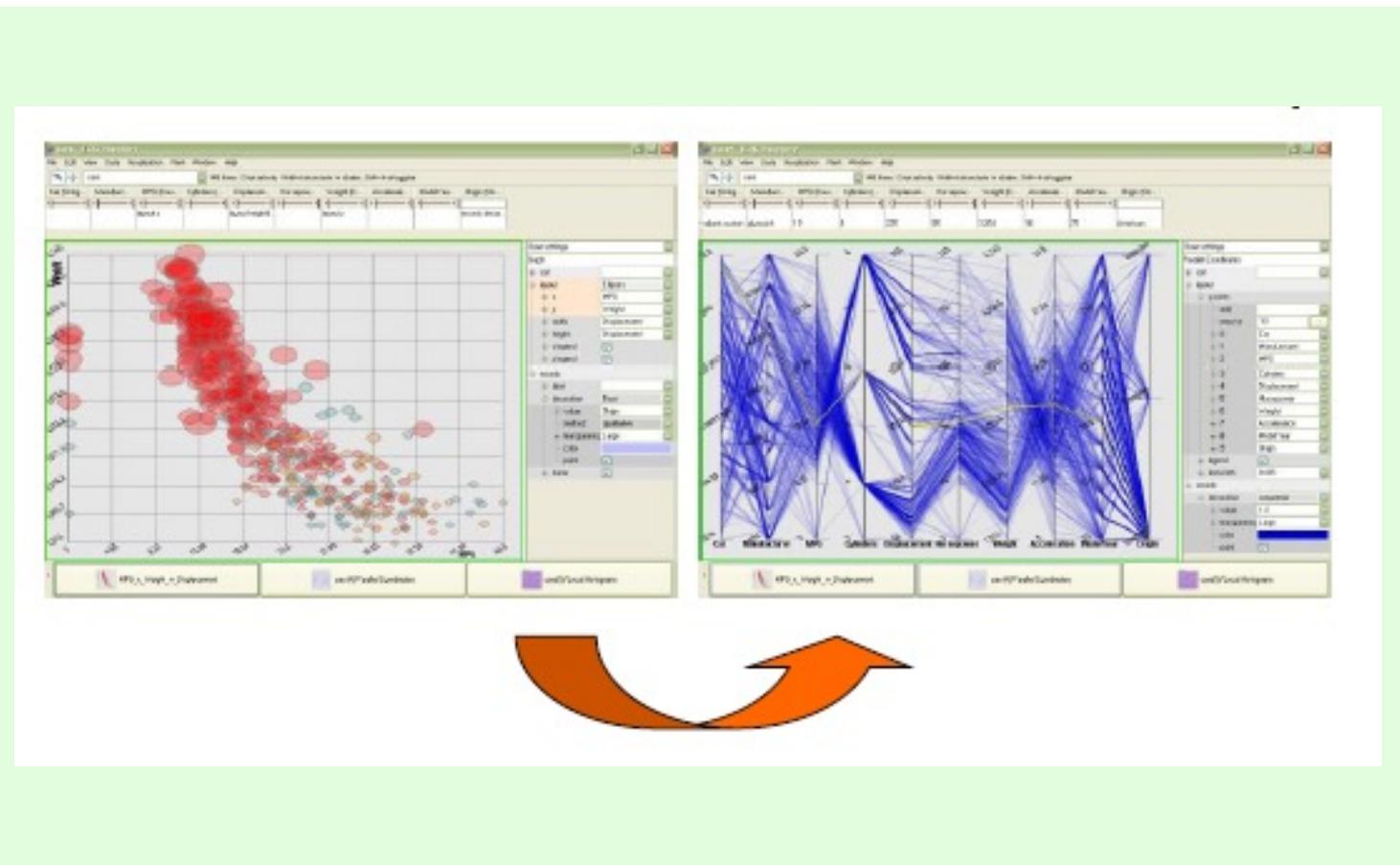
- “Show me a different representation.”
- Change visual appearances.
- Examples
 - Changing color encoding
 - Changing size
 - Changing orientation
 - Changing font
 - Changing shape



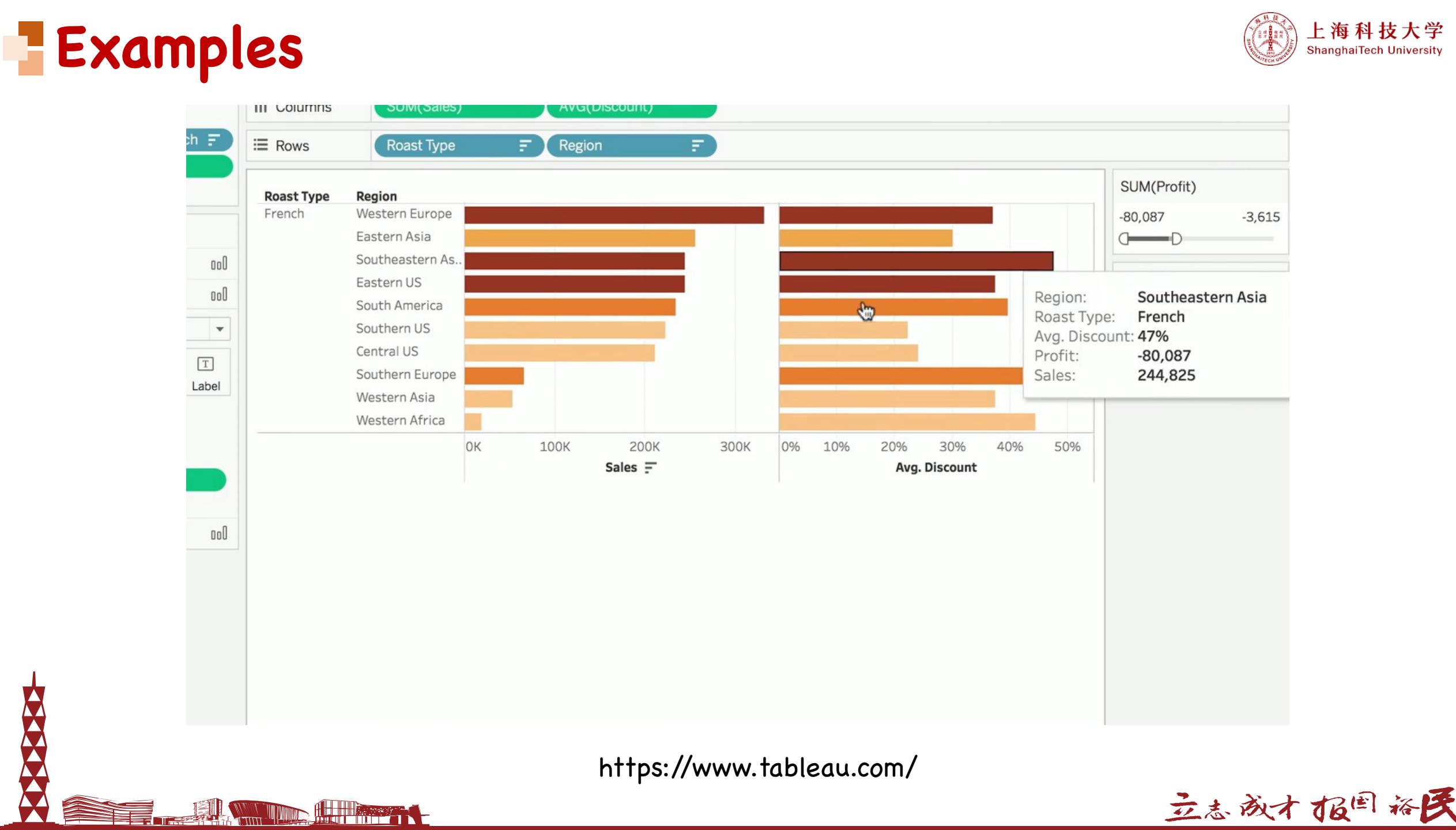
<https://github.com/d3/d3/wiki/Gallery>



Examples



- Selecting different representation from options at the bottom



Examples

GLO-STIX: Graph-Level Operations for Specifying Techniques and Interactive exploration

The screenshot shows the GLO-STIX software interface. On the left, there is a sidebar titled "Select GLOs" containing a list of various graph-level operations. Some items are collapsed under headings like "Positioning Nodes" and "Modifying Elements". On the right, the main area displays a network graph with nodes and curved edges. Below the graph, there is a toolbar with several icons and a small preview window showing a different view of the data.

Select GLOs

- Positioning Nodes
 - Align Left
 - Align Center
 - Align Right
 - Align Top
 - Align Middle
 - Align Bottom
 - Evenly Distribute on X
 - Evenly Distribute on Y
 - Evenly Distribute on X by Category
 - Evenly Distribute on Y by Category
 - Substrate on X by Gender
 - Substrate on Y by Category
 - Evenly Distribute on X Within Substrates
- Modifying Elements
 - Relocate
 - Cleaning
 - Aggregation
 - Alleviating Disjoint Periods

Applied GLOs

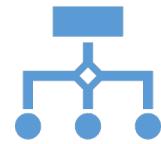
- Category
- Align Left
- Links to Curved
- Set Source Generation 0
- Remove Generation 1
- Substrate on Y by Category
- Show All Links
- Substrate on X by Gender
- Show X Axis
- Show Y Axis
- Aggregate by Gender and Category
- Deaggregate Generation 2

Stolper et al. Glo-stix: Graph-level operations for specifying techniques and interactive exploration. IEEE TVCG, 2014.
<https://www.youtube.com/watch?v=a7ZkZRU6VBM>

立志成才报国裕民

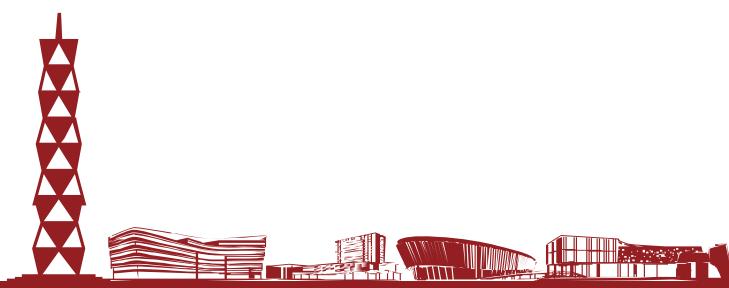
A close-up photograph of a DNA microarray slide, showing a grid of small, dark spots on a light background, representing individual genes or DNA samples.

Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect



Abstract/Elaborate

- “Show me more or less detail”
- Adjust the level of abstraction (overview and details)
- Examples
 - Unfolding sub-categories in an interactive pie chart
 - Drill-down in Treemap
 - Details-on-demand in Sunburst
 - The tool-tip operation in SeeIT
 - Zooming (geometric zooming)





Examples

- Photo set abstraction

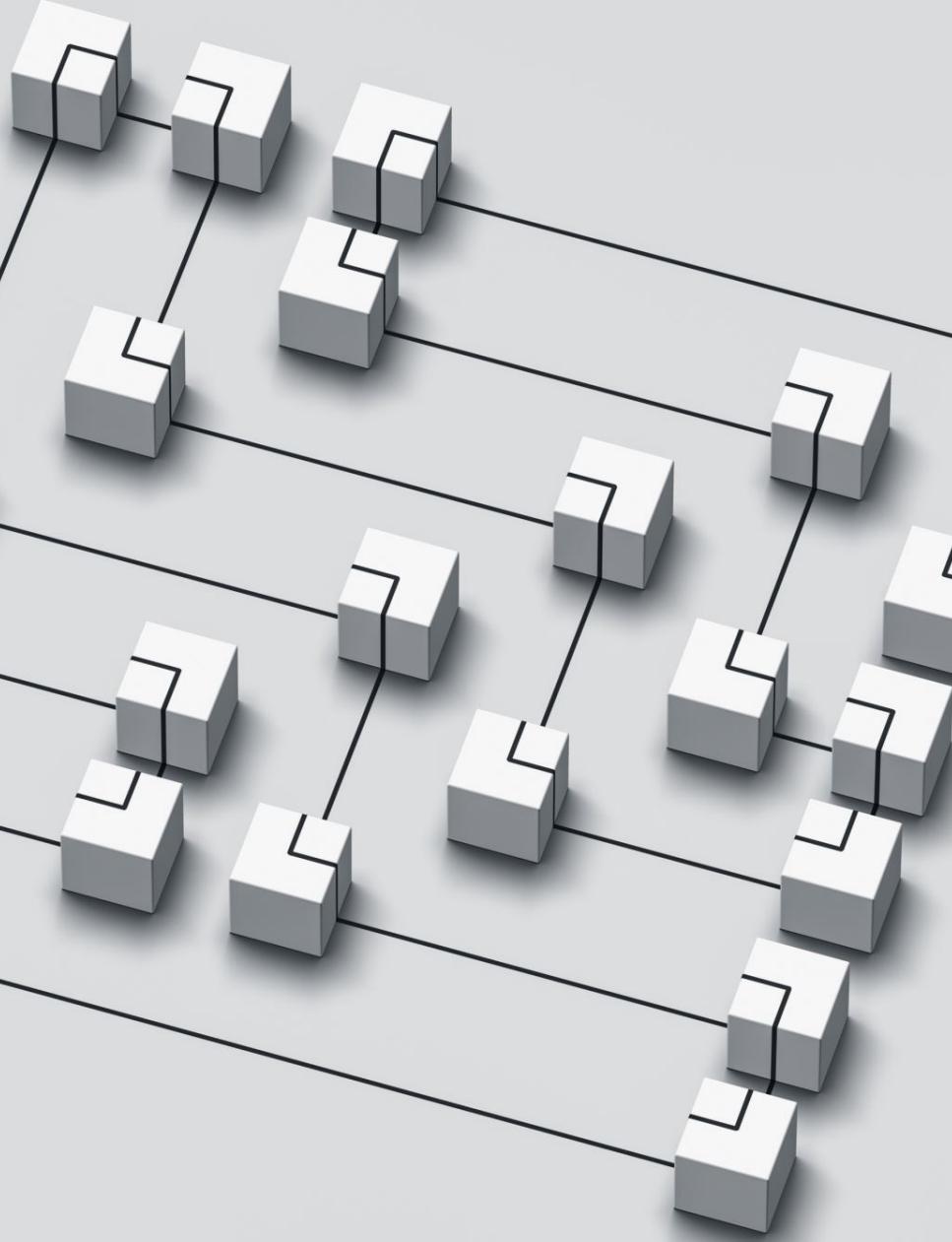
PhotoMesa 3.1

Windsor Interfaces, Inc.

www.photomesa.com

<https://www.youtube.com/watch?v=CQYDhnBMoFO>

立志成才报国裕民



Details-on-Demand

- Term used in infovis when providing viewer with more information/details about data case or cases.
- 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.

Examples

SmartAdP

Data Set
Using: Tianjin Taxi Trajectory ▾

Target Area
OD Heatmap Road
39.1072, 117.1676
39.1071, 117.1828
39.1166, 117.1691

Solution Area
Mark favorite places
39.1083, 117.1899
39.1081, 117.1794
39.1097, 117.1796
39.1146, 117.1842
39.1146, 117.1841
39.1097, 117.1795
39.1127, 117.1889
39.1034, 117.1787
39.1072, 117.1936

Solution Parameters
Number of Billboards: 8
Normal Trajectory Weight: 1
Target Trajectory Weight: 1,000
Temporal Filter: All

Generate Solution
Solution Explorer

Examples



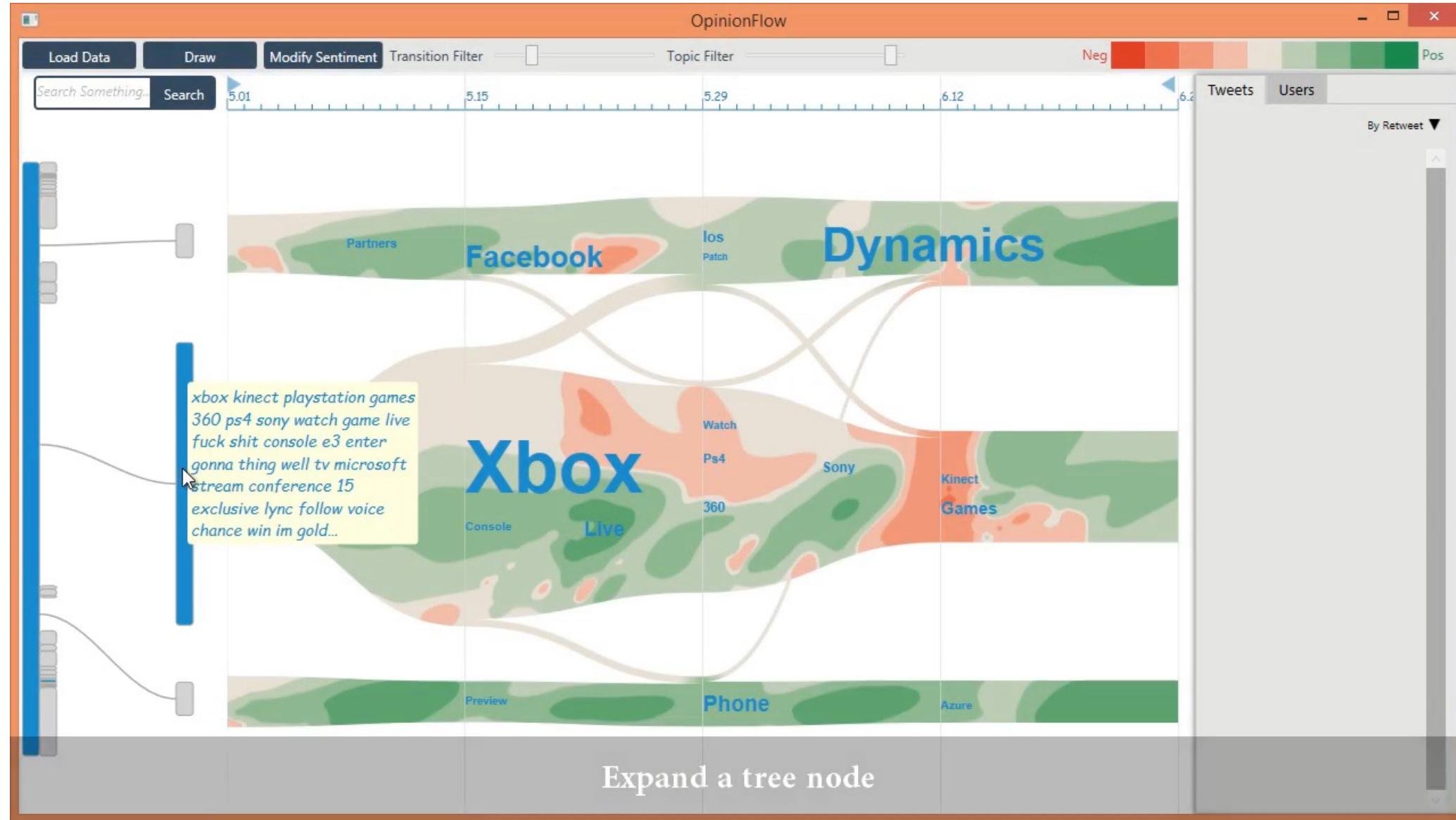
Interaction

Scheepen et al. Rationale visualization for safety and security. Computer Graphics Forum. 2015.
<https://vimeo.com/103142939>





Examples



Examples



Schwab et al. booc. io: An Education System with Hierarchical Concept Maps. IEEE TVCG 2017.
<https://vimeo.com/182970903>



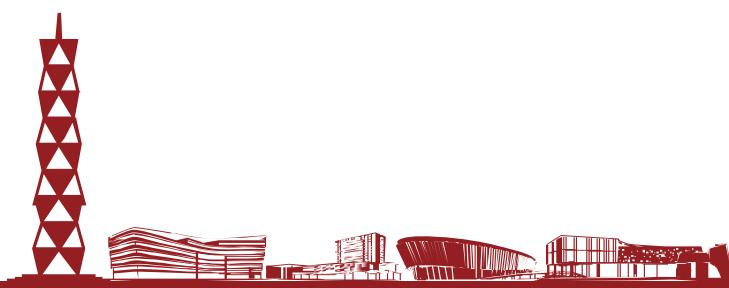


Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect



Filter

- “Show me something conditionally.”
- Change the set of data items being presented based on some specific conditions.
- Examples
 - Dynamic query
 - Attribute Explorer
 - Keystokebased filtering in NameVoyager
 - QuerySketch





Method 1: Filtering/Limiting

- Fundamental interactive operation in infovis is changing the set of data cases being presented.
 - Focusing
 - Narrowing/widening





Method 1: Filtering/Limiting

The screenshot shows the 'The Baby Name Wizard expert' interface. At the top, there are tabs for 'NameVoyager Expert', 'Expert NameFinder', 'Name MatchMaker', 'Logout', 'Manage my Account', and a search bar. Below the tabs are links for 'NameFinder', 'Namipedia', 'NameVoyager', 'NameMapper', 'Blog', 'About the Book', and a pink 'namecandy >>' button.

1. Names You Like: Enter one or more names that appeal to you to get suggestions with a similar style. There are three input fields, each with a 'boy' and 'girl' radio button.

MATCH NAMES

2. Control Panel: You can adjust factors you care about to help the MatchMaker understand your personal taste.

Show Me: girl boy both **APPLY**

I prefer names with these qualities...

Current Popularity Level: Rare Popular

All-Time Peak Popularity: Rare Popular

Length (in letters): Short Long

3. Style and Culture Preferences:

	Prefer	Avoid		Prefer	Avoid
African	<input type="radio"/>	<input checked="" type="radio"/>	Traditional	<input type="radio"/>	<input checked="" type="radio"/>
African-American	<input type="radio"/>	<input checked="" type="radio"/>	Contemporary	<input type="radio"/>	<input checked="" type="radio"/>
Celtic	<input type="radio"/>	<input checked="" type="radio"/>	Unexpected	<input type="radio"/>	<input checked="" type="radio"/>
French	<input type="radio"/>	<input checked="" type="radio"/>	Creative Spelling	<input type="radio"/>	<input checked="" type="radio"/>
German/Dutch	<input type="radio"/>	<input checked="" type="radio"/>	Androgynous	<input type="radio"/>	<input checked="" type="radio"/>
Greek	<input type="radio"/>	<input checked="" type="radio"/>	Nickname	<input type="radio"/>	<input checked="" type="radio"/>

MatchMaker Suggestions **Symbols Key**

Name	Rank	Graph	Trend	Celeb	Book	Fave This!
[Placeholder]						

<http://www.babynamewizard.com/baby-names-expert-upgrade-video-1>





Method 2: Dynamic Query

- Probably best-known and one of most useful infovis techniques
- Let's explore more details...

DB Query

Query language

```
- Select house-address  
From atl-realty-db  
Where price >= 200,000 and  
    price <= 400,000 and  
    bathrooms >= 3 and  
    garage == 2 and  
    bedrooms >= 4
```

Usually we will get

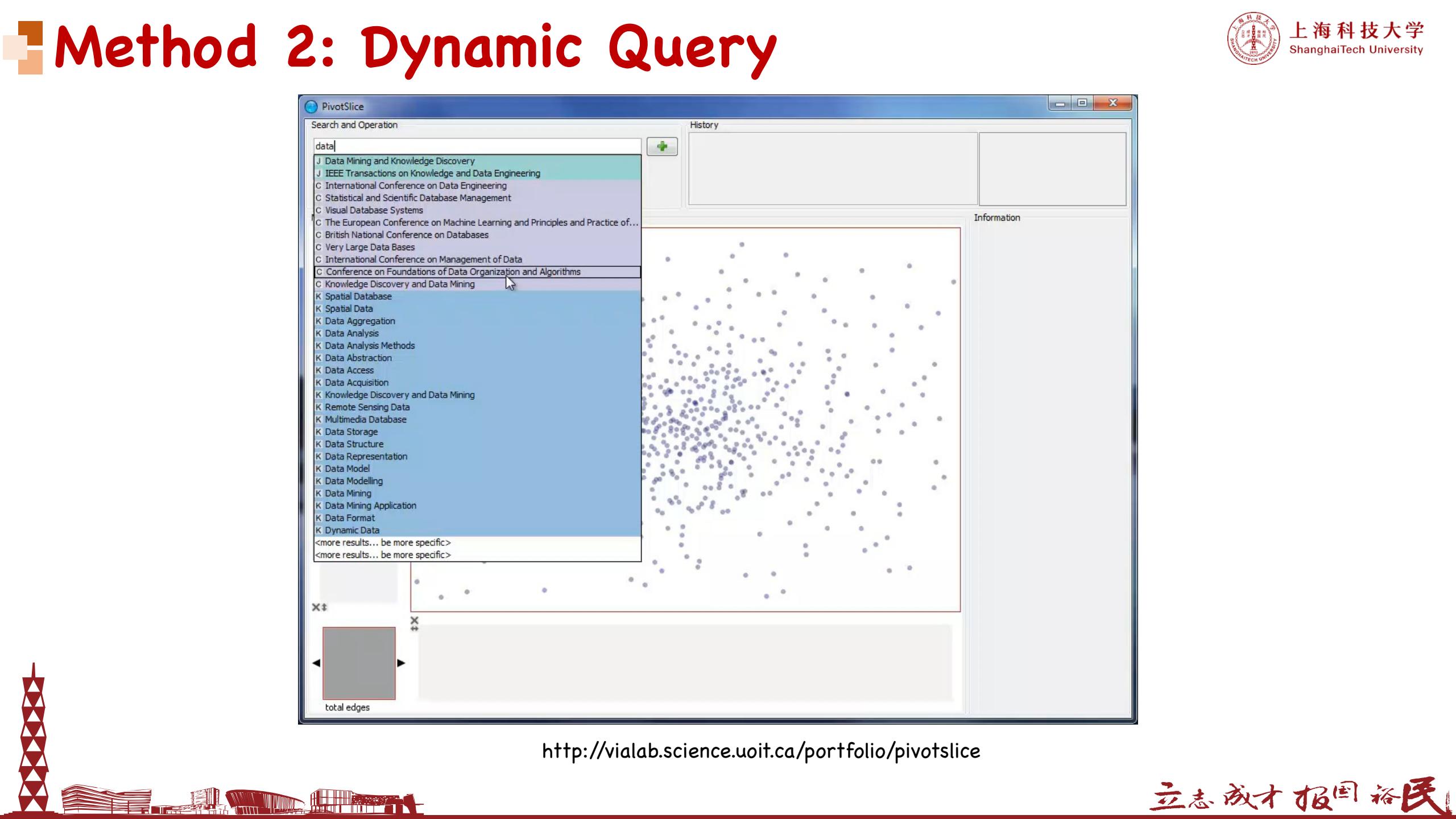
- 124 hits found
 - 1. 748 Oak St. - a beautiful ...
 - 2. 623 Pine Ave. -
 - ...
- 0 hits found





Method 2: Dynamic Query

- Dynamic queries continuously update the data that is filtered from the database and visualized.
- An interface that allows **dynamic queries** has these properties ([Williamson and Shneiderman, 1992]):
 - Graphical representation of the request
 - the graphical visualization of the database and searching results
 - delivers results immediately when several parameters are changed
 - visualizes result borders (min-max)
 - allows beginners a faster entrance without having much practice, and still offers experts some mighty functions

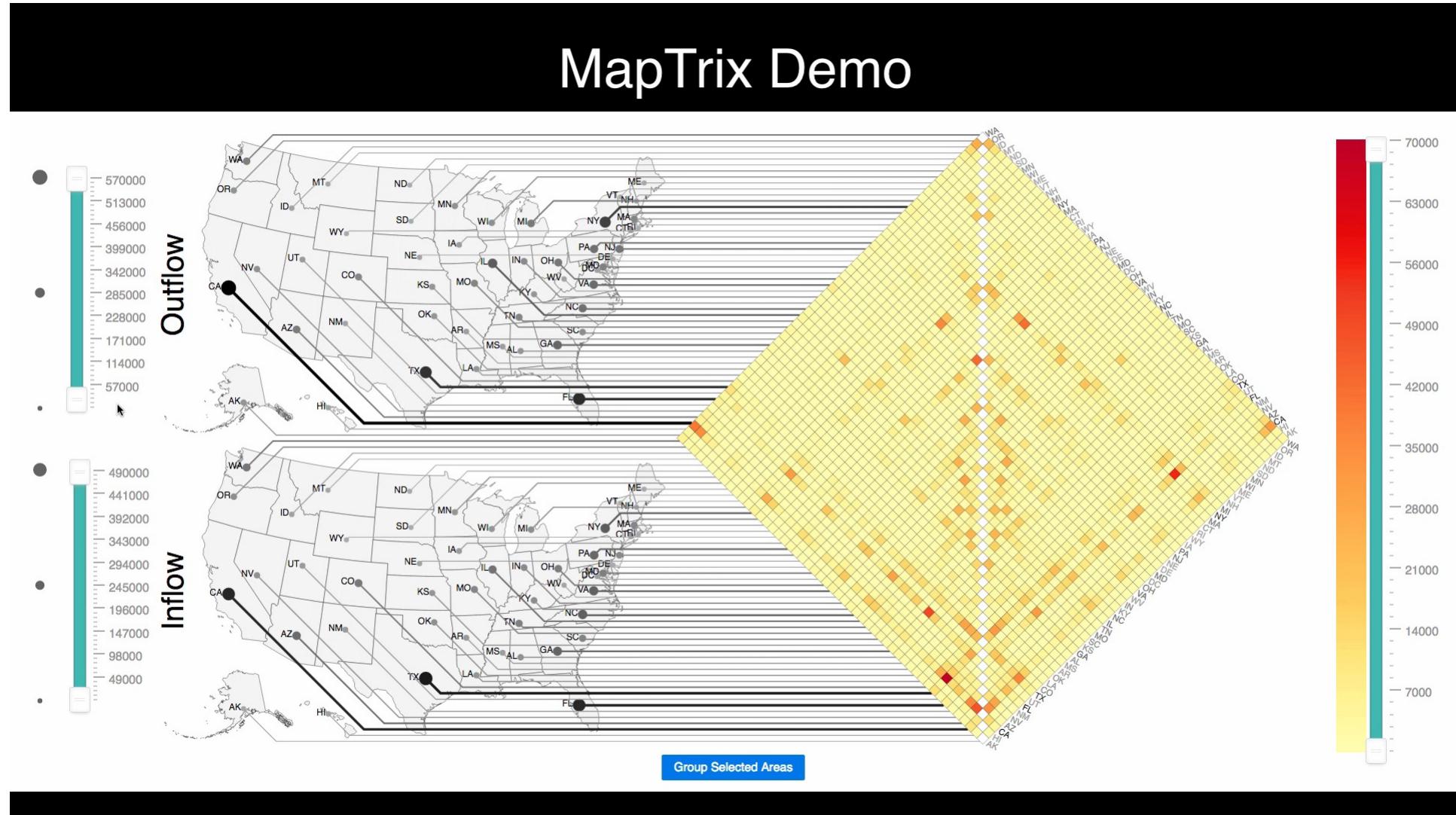


Method 2: Dynamic Query

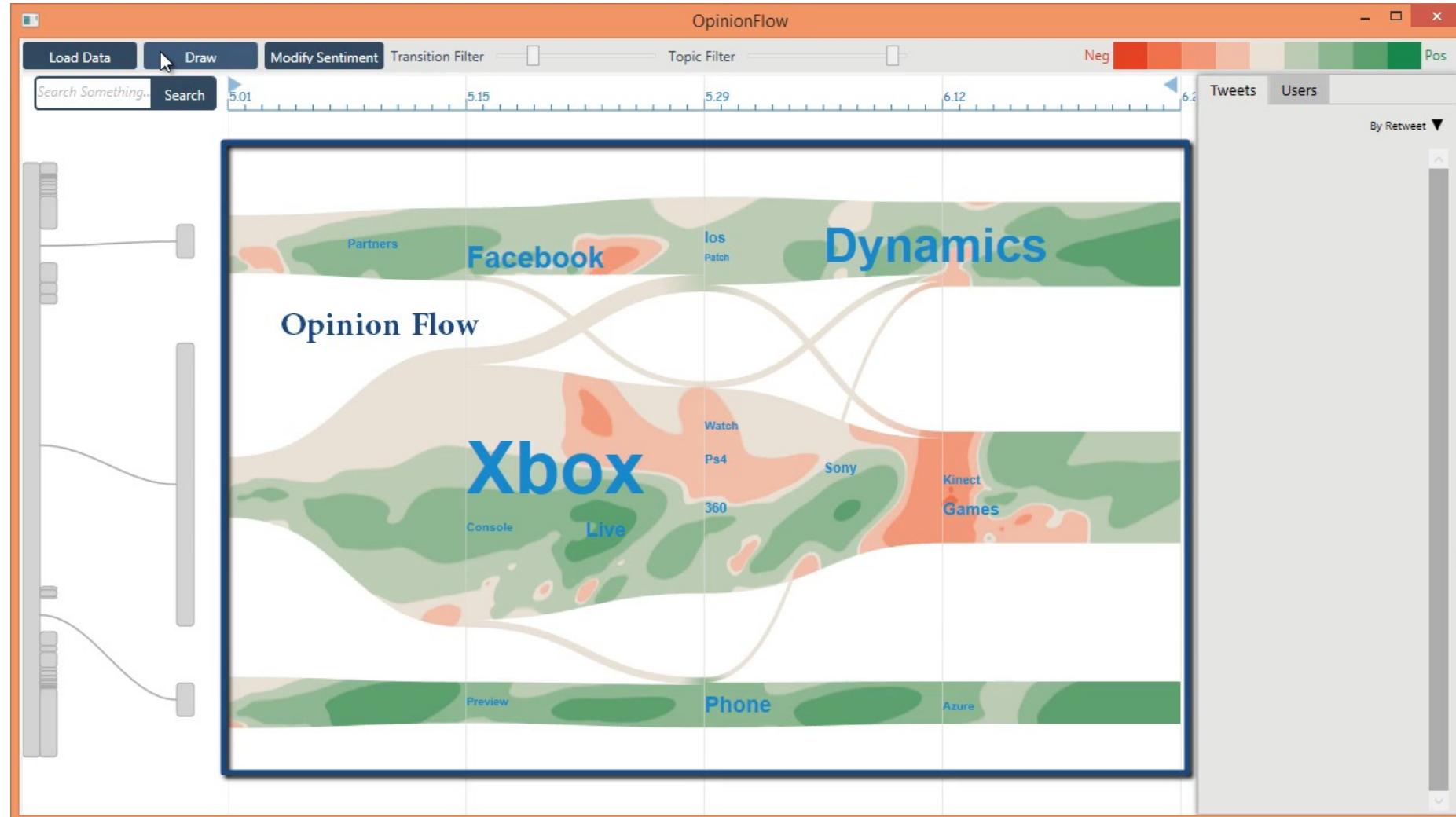


<http://vialab.science.uoit.ca/portfolio/pivotslice>

Method 2: Dynamic Query

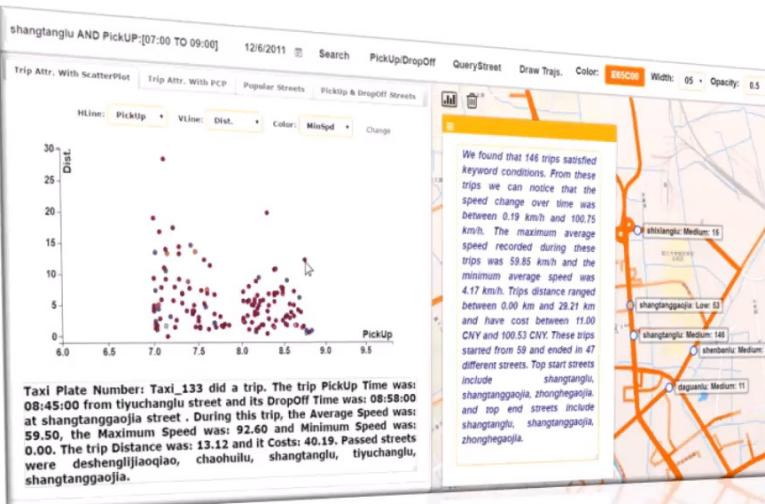


Method 2: Dynamic Query



Method 2: Dynamic Query

SemanticTraj: A New Approach to Interacting with Massive Taxi Trajectories



Shamal Al-Dohuki, Farah Kamw, Ye Zhao,
Jing Yang, Chao Ma, Yingyu Wu, Xinyue Ye,
Fei Wang, Xin Li, Wei Chen



Al-Dohuki, et al. SemanticTraj: A new approach to interacting with massive taxi trajectories. IEEE TVCG 2017.
<https://www.youtube.com/watch?v=Q-MyhZlwEbM>



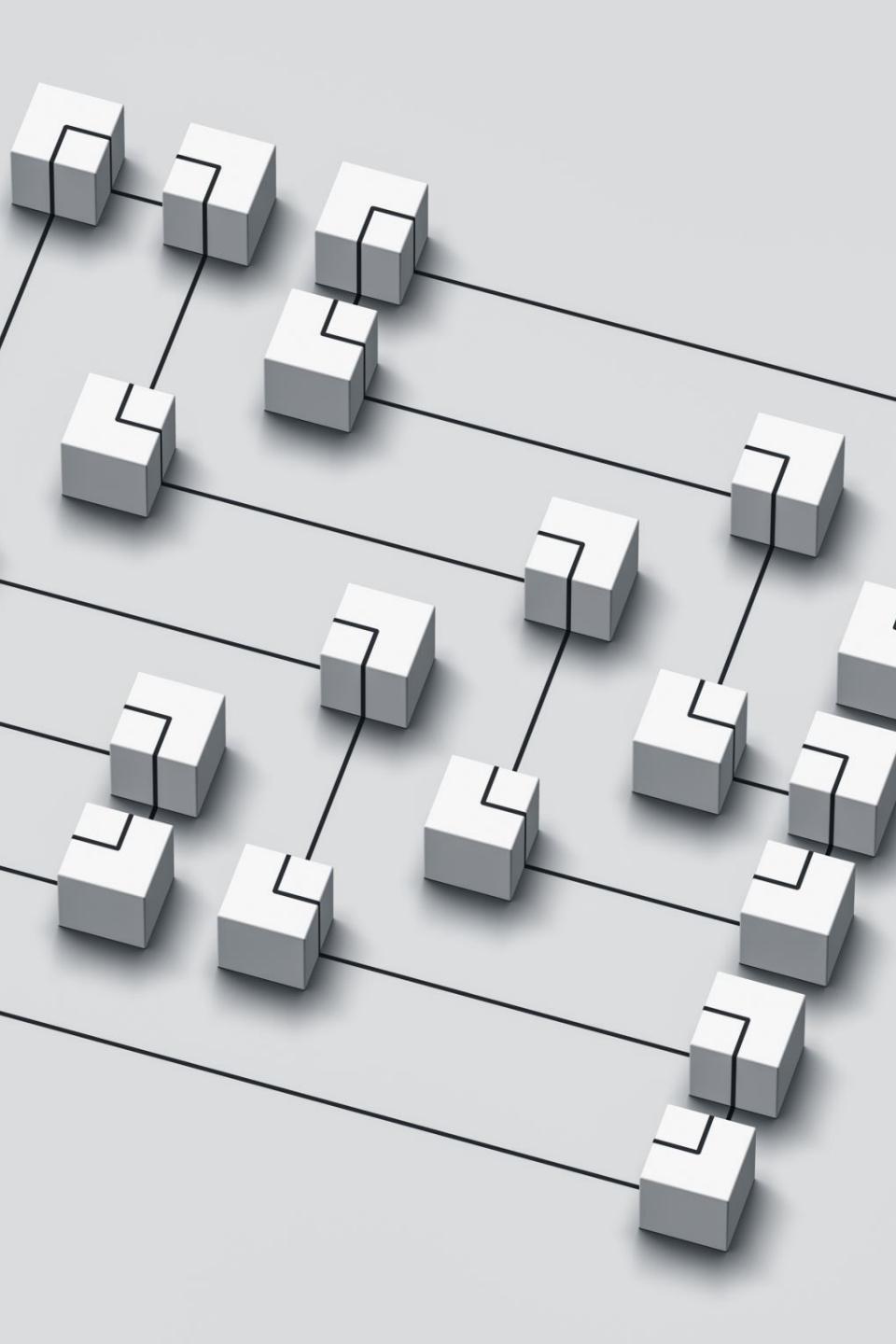
DQ Strengths

- Work is faster.
- Promote reversing, undo, exploration.
- Very natural interaction.
- Directly shows the data.



DQ Weaknesses

- Operations are fundamentally conjunctive.
- Can you formulate an arbitrary boolean expression?
$$!(A_1 \cup A_2) \cap A_3 \cup (A_4 \cup A_5 \cap A_6) \cup \dots$$
- Controls are global in scope.
- They affect everything.
- Controls must be fixed in advance.



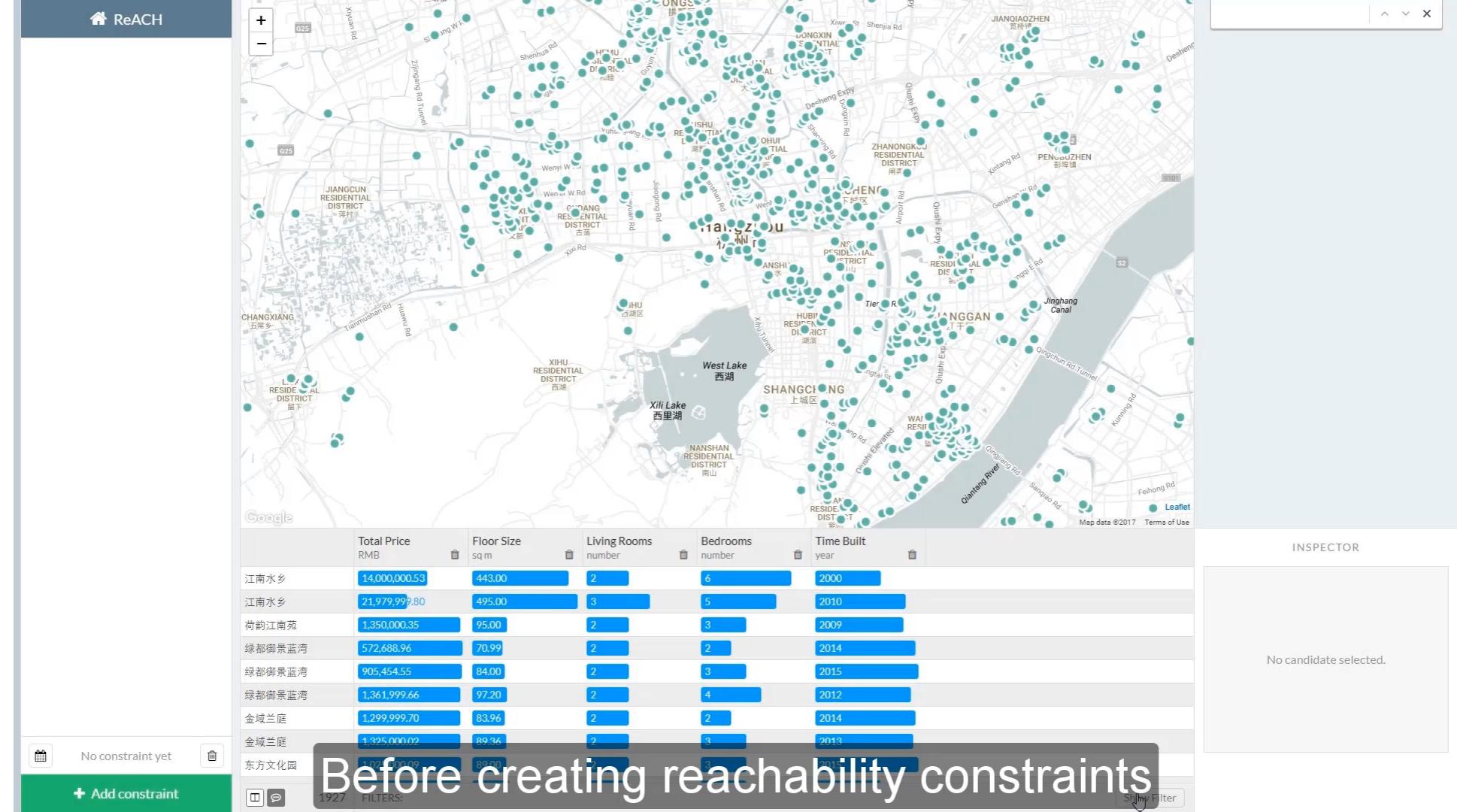
DQ Weaknesses

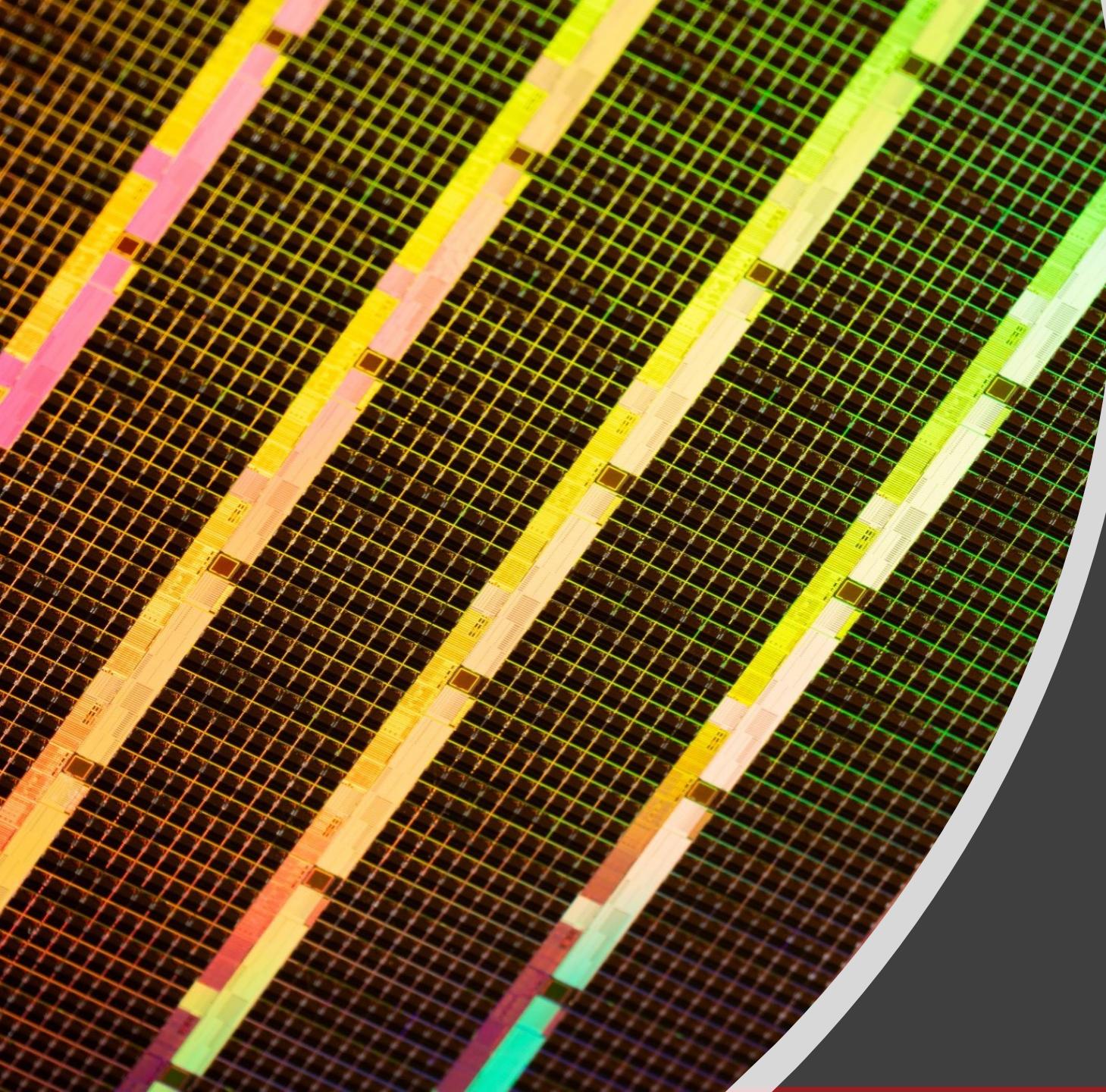
- As data set gets larger, real-time interaction becomes increasingly difficult.
- Storage -Data structures:
 - Linear array
 - Grid file
 - Quad, k-d trees
 - Bit vectors

Brushing Histogram

- Special case of brushing.
- Data values represented in histograms that can be clicked on and selected (controls region).
- When items selected there, the corresponding item(s) are highlighted in main view windows.
- Application:
 - Transfer function design of 3D volume data field.

Example





Select
Explore
Reconfigure
Encode
Abstract/Elaborate
Filter
Connect

Connect

“Show me related items.”

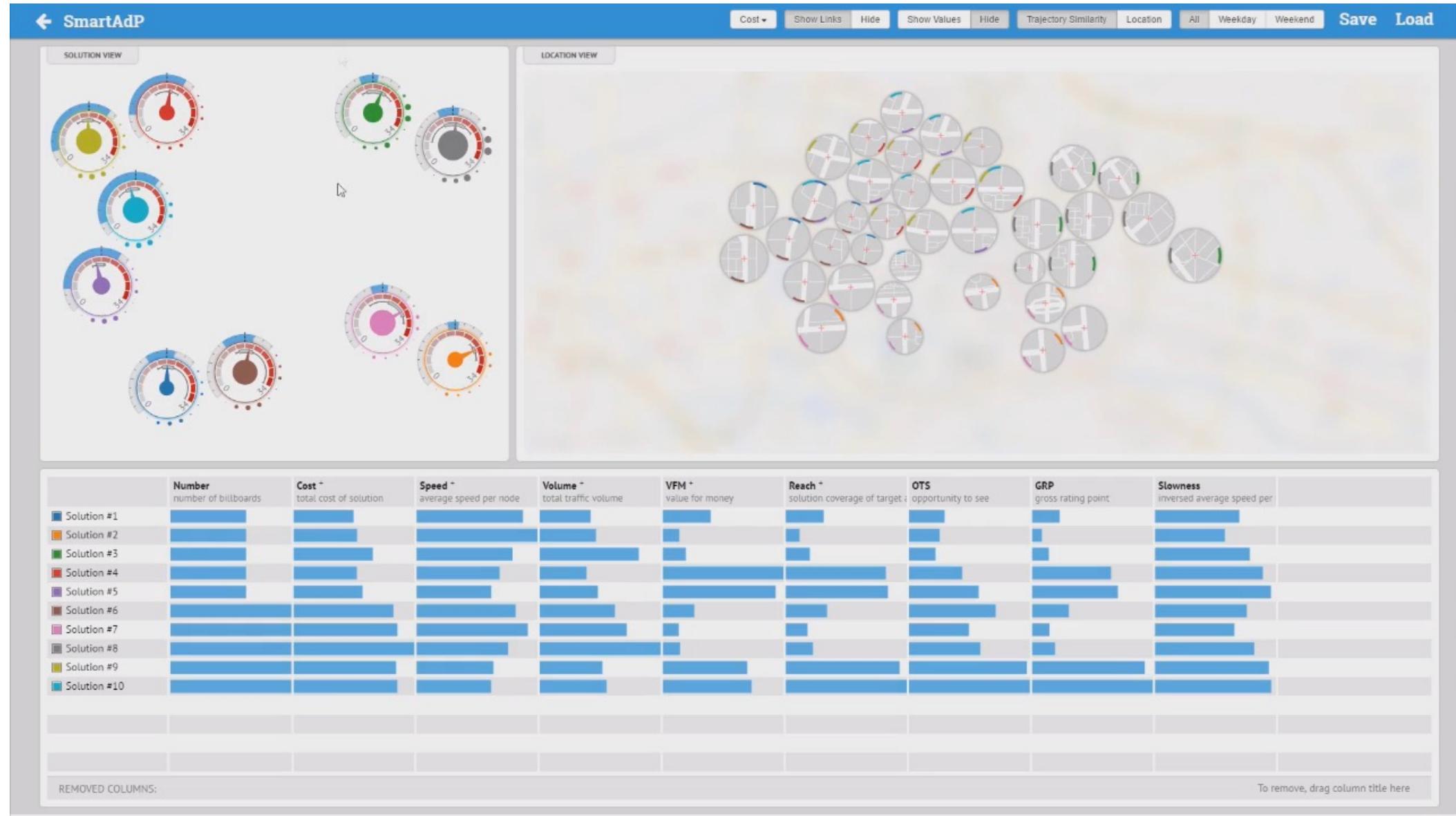
Highlight associations and relationships.

Show hidden data items that are relevant to a specified item.

Examples:

- Highlighting directly connected nodes in Vizster
- Brushing in InfoScope

Explicit Connection



立志成才报国裕民



Highlighting Connections

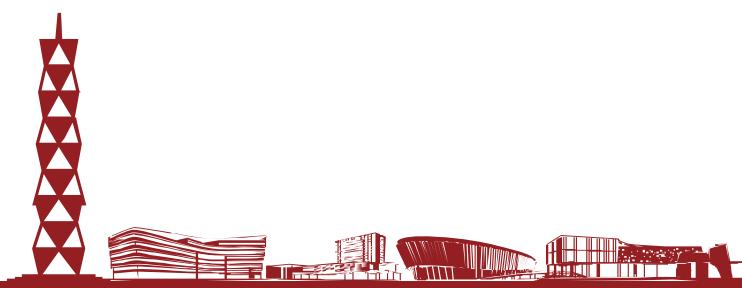
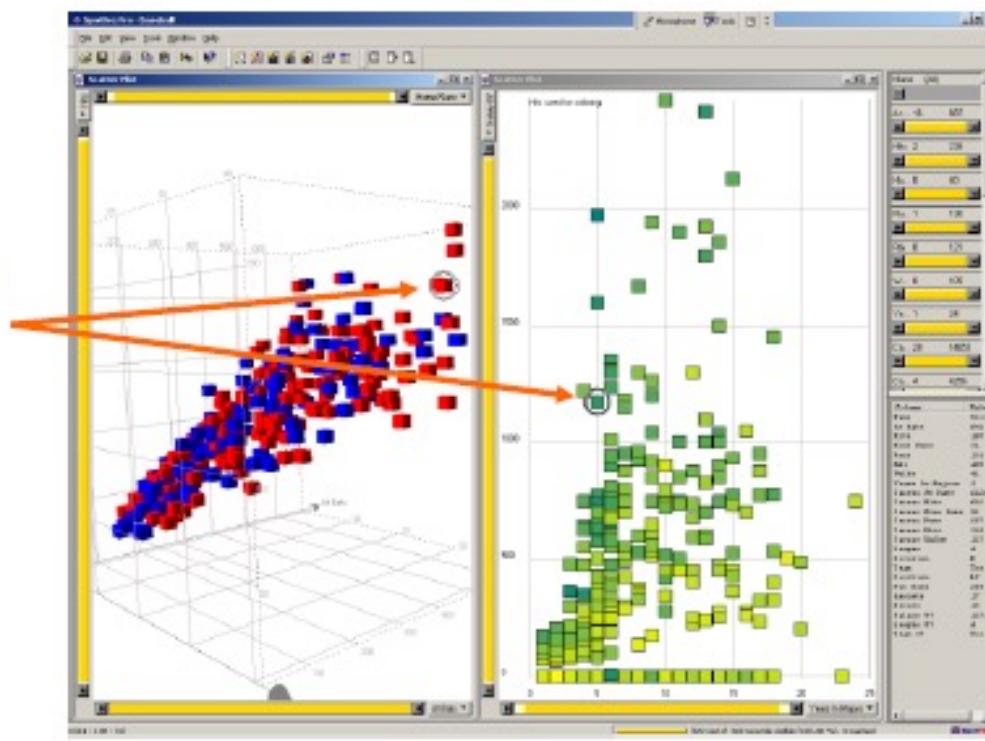
- Viewer may wish to examine different attributes of a data case simultaneously.
- Alternatively, viewer may wish to view data case under different perspectives or representations.
- But need to keep straight where the data case is.

Brushing

- Very common technique in InfoVis
- Applies when you have multiple views of the same data

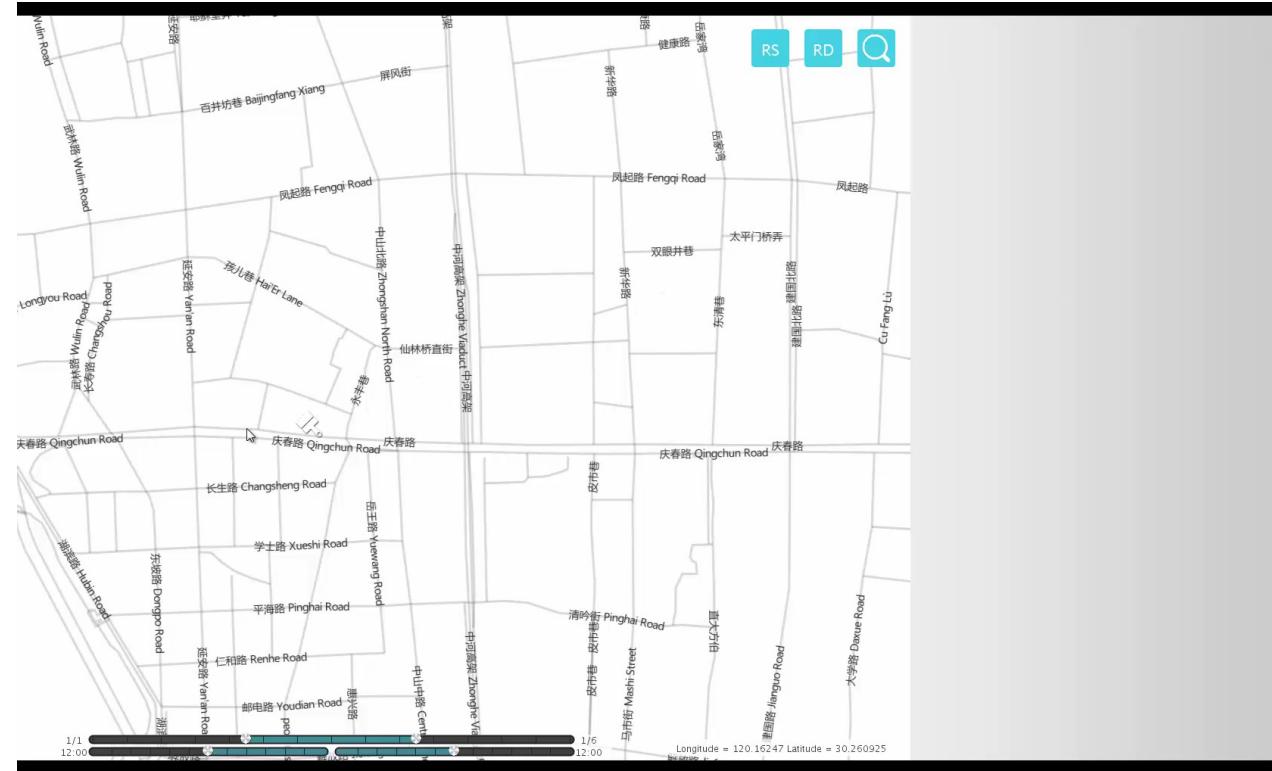
Selecting or
highlighting a case in
one view generates
highlighting the case
in the other views

Same item



Example

- Very common technique in InfoVis
- Applies when you have multiple views of the same data

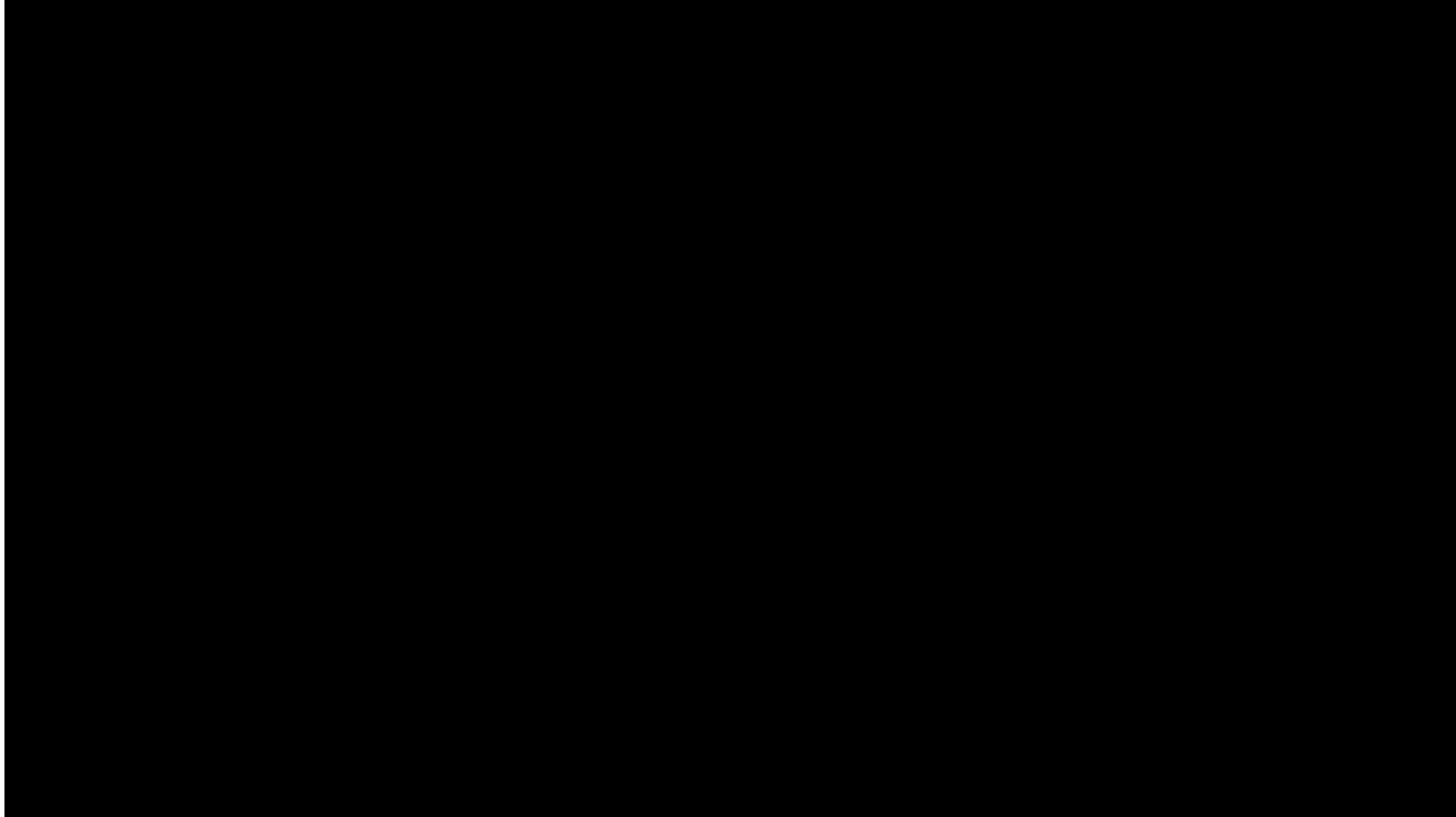


Wang et al. A visual reasoning approach for data-driven transport assessment on urban roads. IEEE TVCG 2014.
[http://www.cad.zju.edu.cn/home/vagblog/VAG_Work/IEEEVis2014/TaxiHash_Wangfei/wang%20\(1\).mp4](http://www.cad.zju.edu.cn/home/vagblog/VAG_Work/IEEEVis2014/TaxiHash_Wangfei/wang%20(1).mp4)





Example



Yalcin et al. AggreSet: Rich and scalable set exploration using visualizations of element aggregations. IEEE TVCG 2016.
<https://www.youtube.com/watch?v=cSSAvDAre-E>





Embedded Merge & Split : Visual Adjustment of Data Grouping

Ali Sarvghad *, Bahador Saket *, Alex Endert, Nadir Weibel
(* equal contribution)



Sarvghad et al. Embedded Merge & Split: Visual Adjustment of Data Grouping. IEEE TVCG 2018.
<https://www.youtube.com/watch?v=Z2rL6WF6TLY>





OUTLINE

- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design



Overview + Details



- Scale—Many data sets are too large to visualize on one screen.
 - May simply be too many cases.
 - May be too many variables.
 - May only be able to highlight particular cases or particular variables, but viewer's focus may change from time to time.

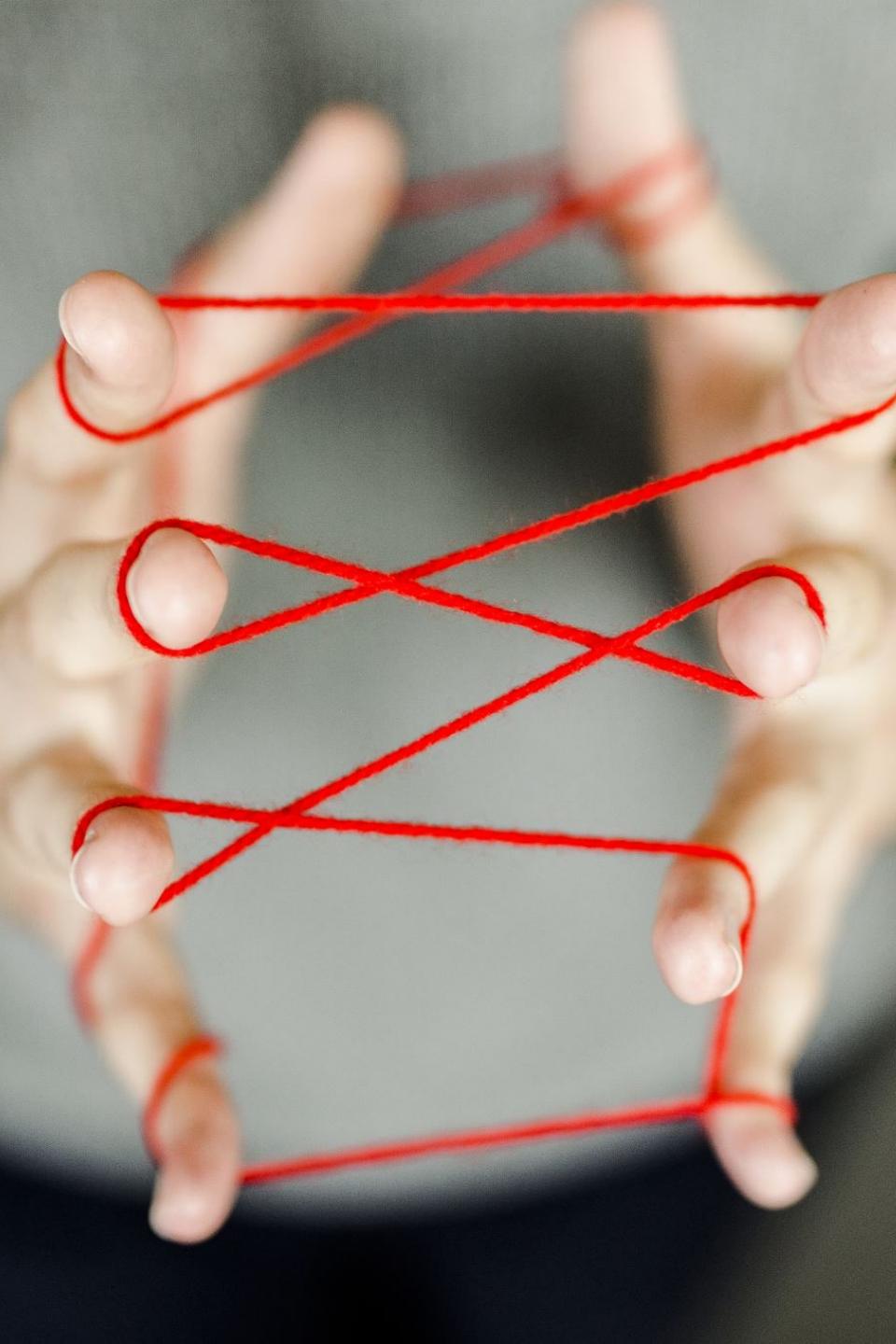


<https://www.arcadevillage.com/>

立志成才报国裕民

Overview + Details

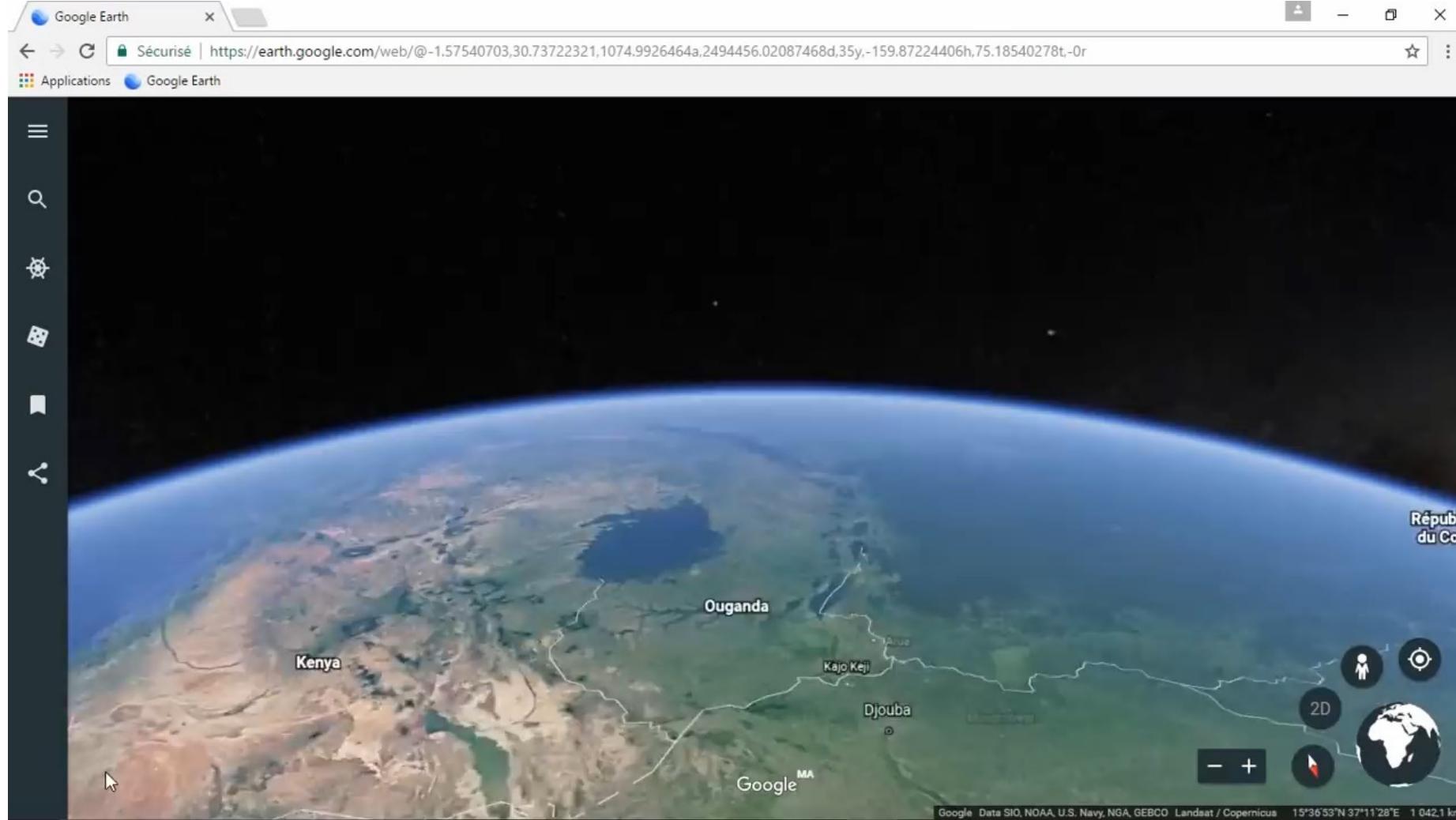
- Potential solutions lie in:
 - Data representation,
 - Interaction,
 - Or both.



Common Solution

- Use scroll:
 - Provide a larger, virtual screen by allowing user to move to different areas.
- It is Still a problem:
 - Clunky interaction.
 - Only get to see one piece.

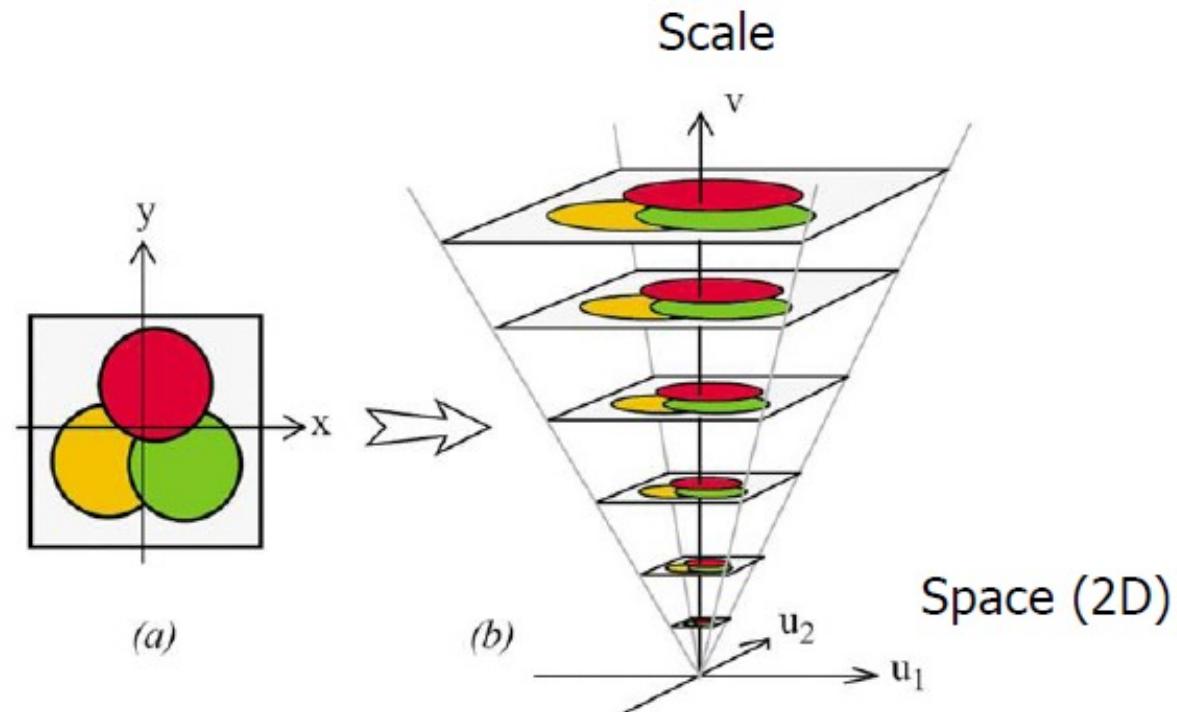
Example



<https://www.youtube.com/watch?v=paqB4FrJN0w>

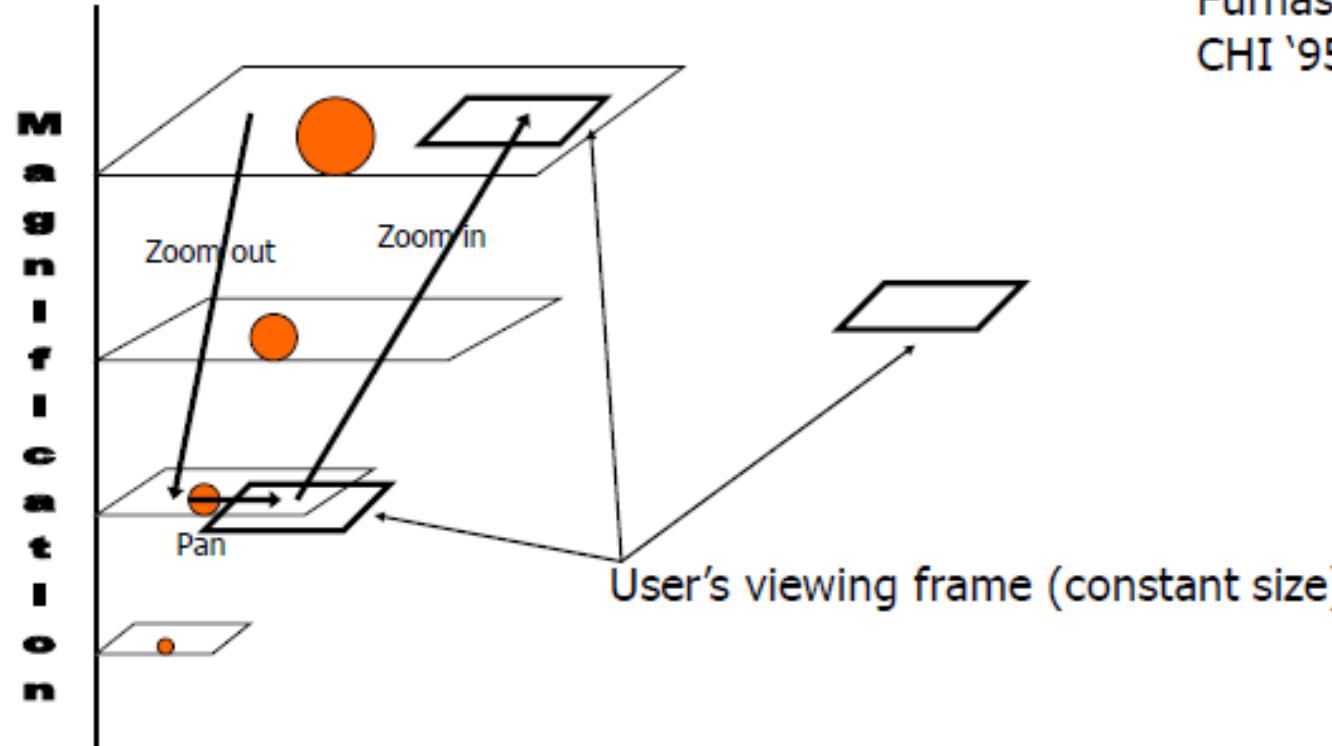
Understanding Zooming

- The space scale diagram
- Operations in zooming



Furnas et al. Space-scale diagrams: Understanding multiscale interfaces. SIGCHI ACM, 1995.

Space-Scale Diagram

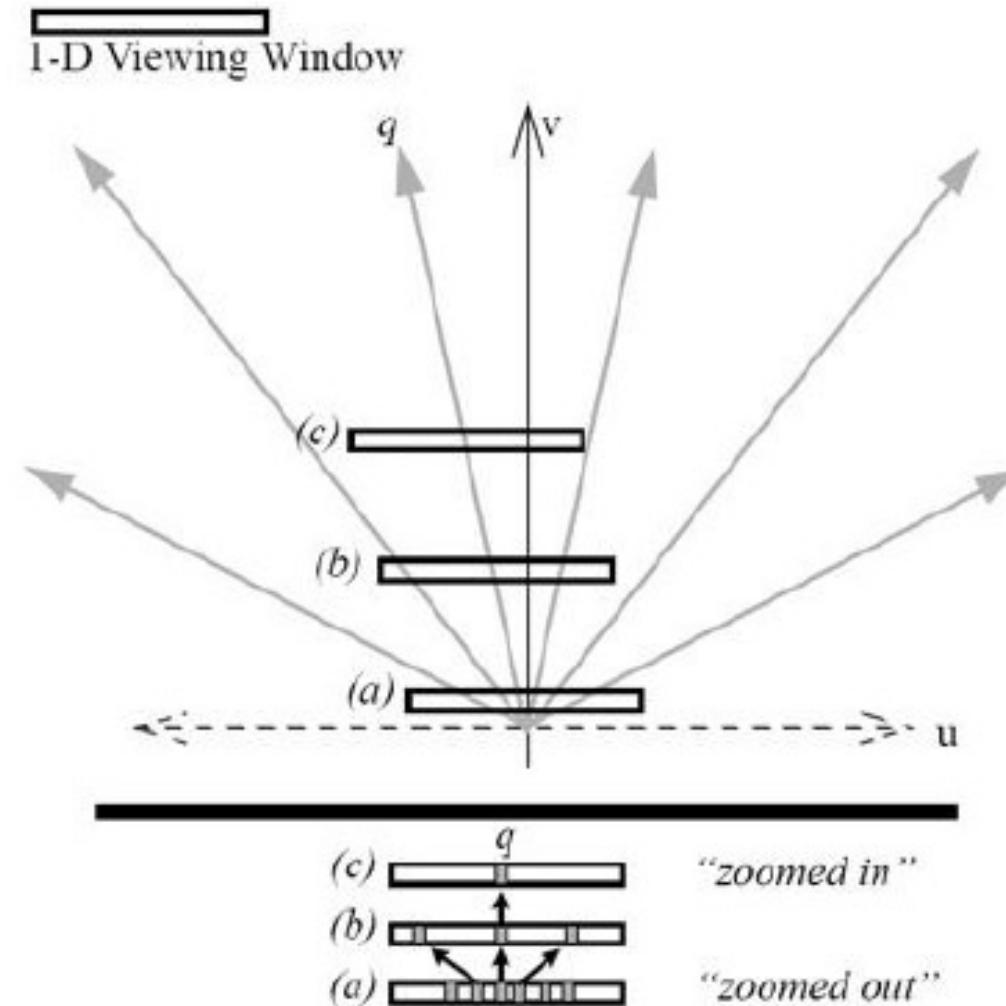


Technique for describing panning and zooming interfaces

Furnas et al. Space-scale diagrams: Understanding multiscale interfaces. SIGCHI ACM, 1995.

立志成才报国裕民

Simplification: 1D Space



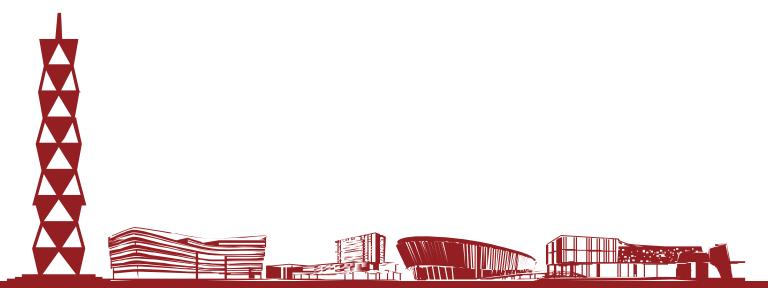
Furnas et al. Space-scale diagrams: Understanding multiscale interfaces. SIGCHI ACM, 1995.

立志成才报国裕民



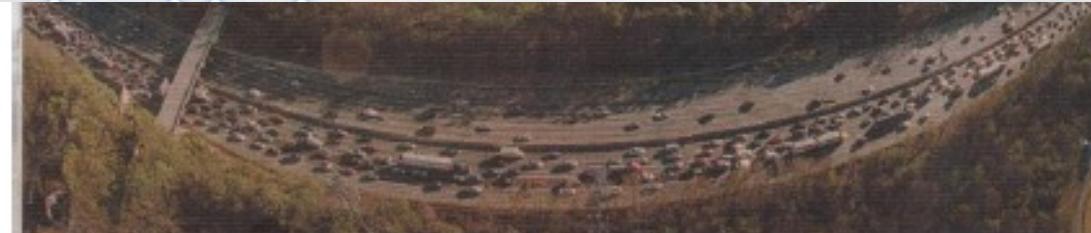
OUTLINE

- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design

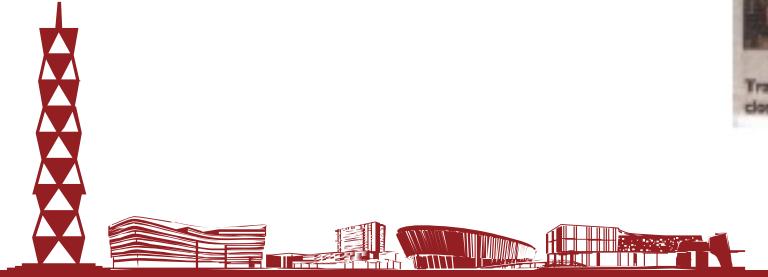


Why is it called Fisheye?

Fisheye Camera Lens



Traffic creeps along I-285 westbound during the evening rush hour Thursday after a hole developed in a bridge over the Chattahoochee River and closed. Officials say recent construction work may have caused the problem. This photo, taken with a fisheye lens, is looking south toward downtown.



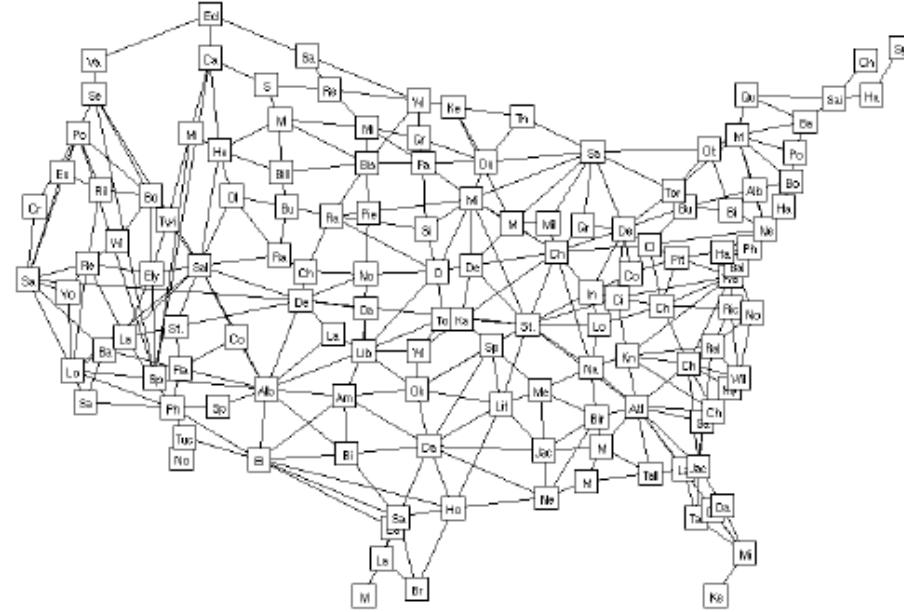


Figure 1: A graph with 134 vertices and 338 edges. The vertices represent major cities in the United States, and the edges represent paths between neighboring cities. (Typically, the edges would be annotated with the distance and driving time between the cities.) The *a priori importance* value assigned to each vertex is proportional to the population of the corresponding city. Fisheye views of this graph appear in Figures 2–6

Sarkar et al. Graphical fisheye views of graphs. SIGCHI ACM, 1992.



立志成才报国裕民

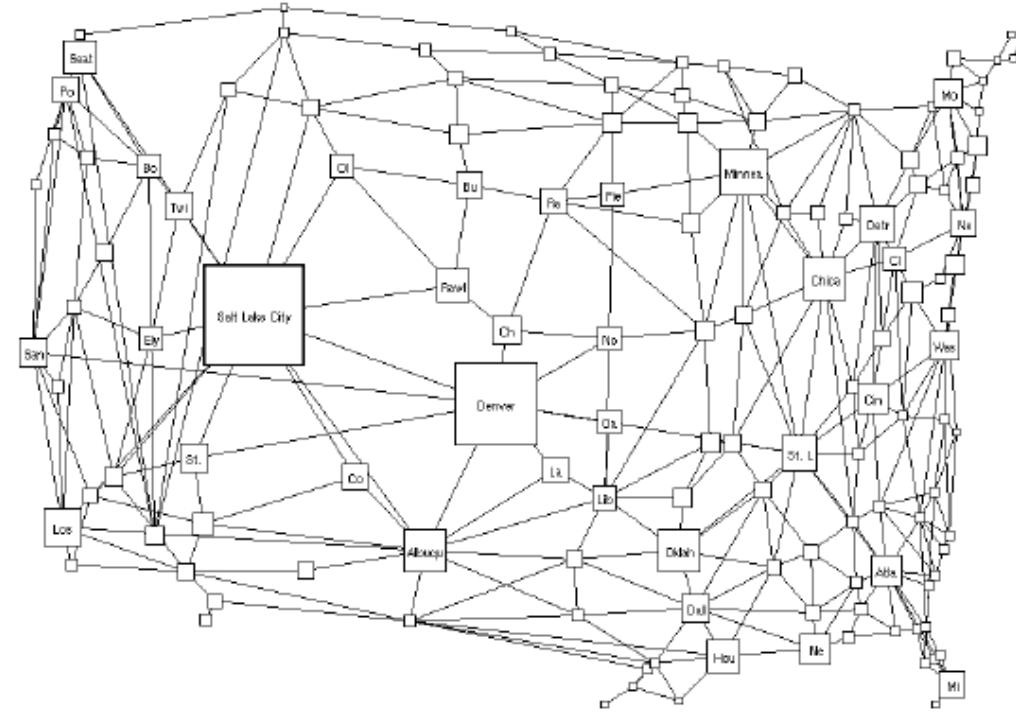
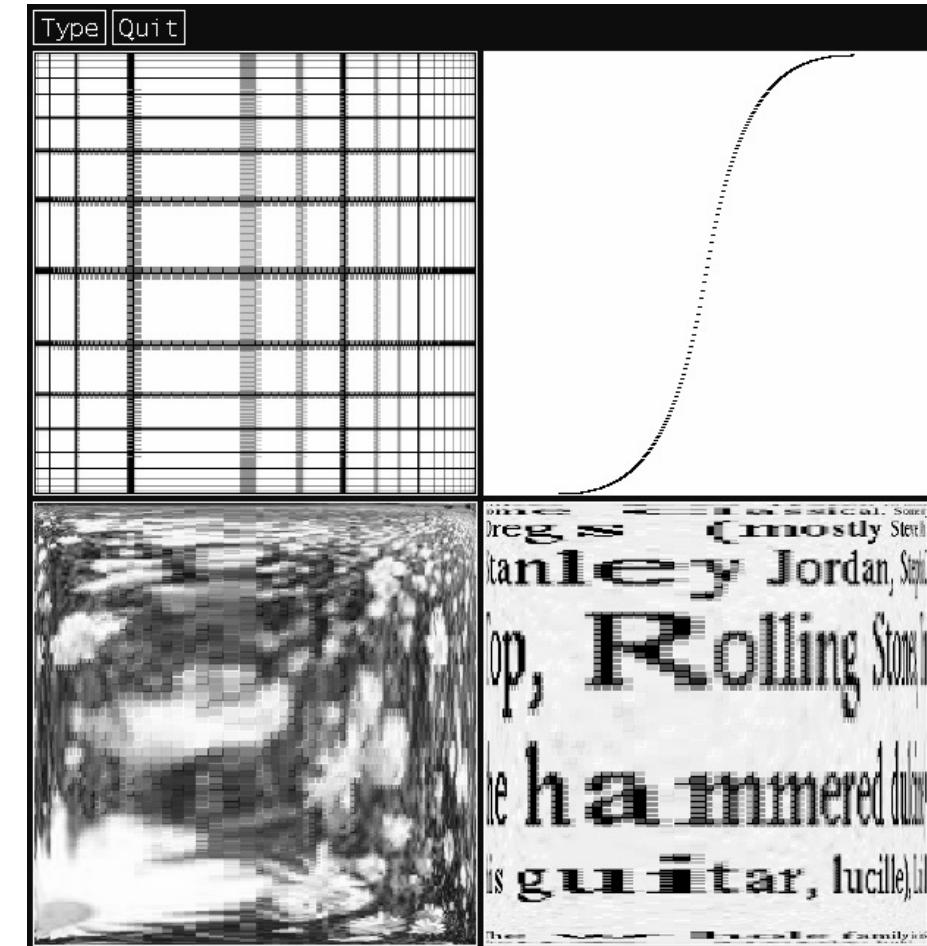
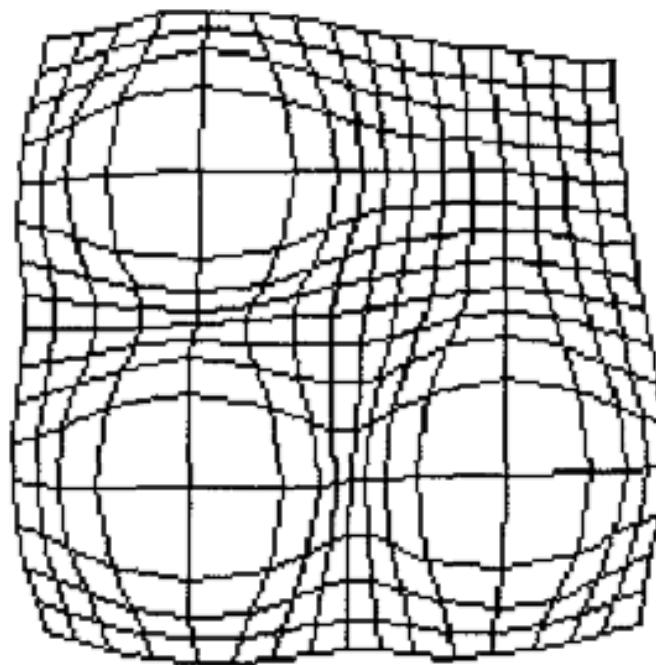


Figure 4: A fisheye view of the graph in Figure 1, with the focus on Salt Lake City. The level of distortion is the same as in Figure 3; only the location of the focus has changed. The values of the fisheye parameters are $d = 2$, $c = 0.5$, $e = 0.5$, $VWcutoff = 0$.

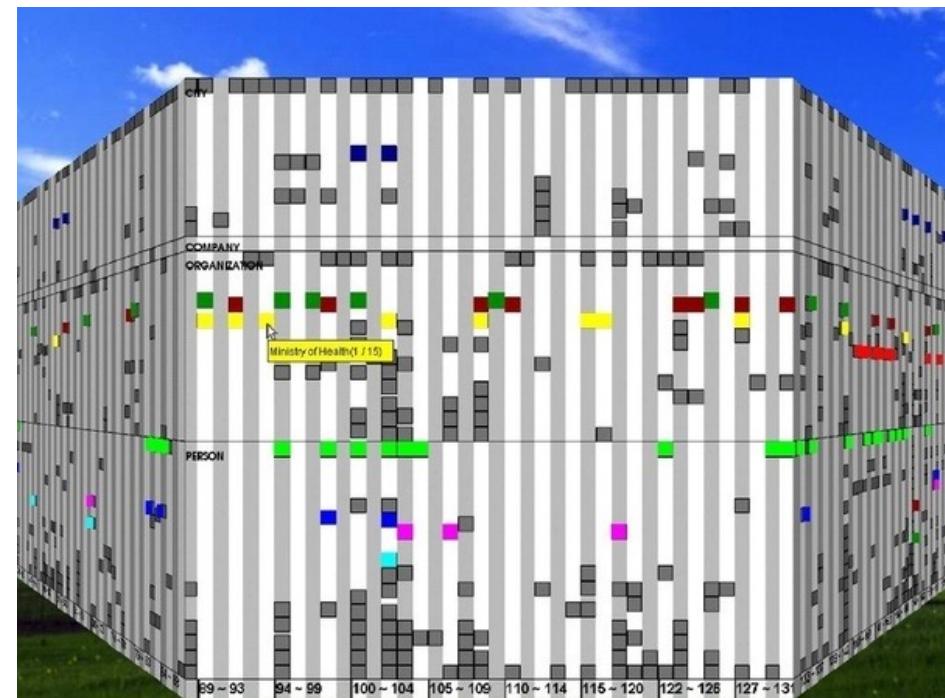
Example

- Multifocal Display



Example

- Computerized, automated 3D implementation of Bifocal display.
- Map work charts onto diagram.
- X-axis is time.
- Y-axis is project.



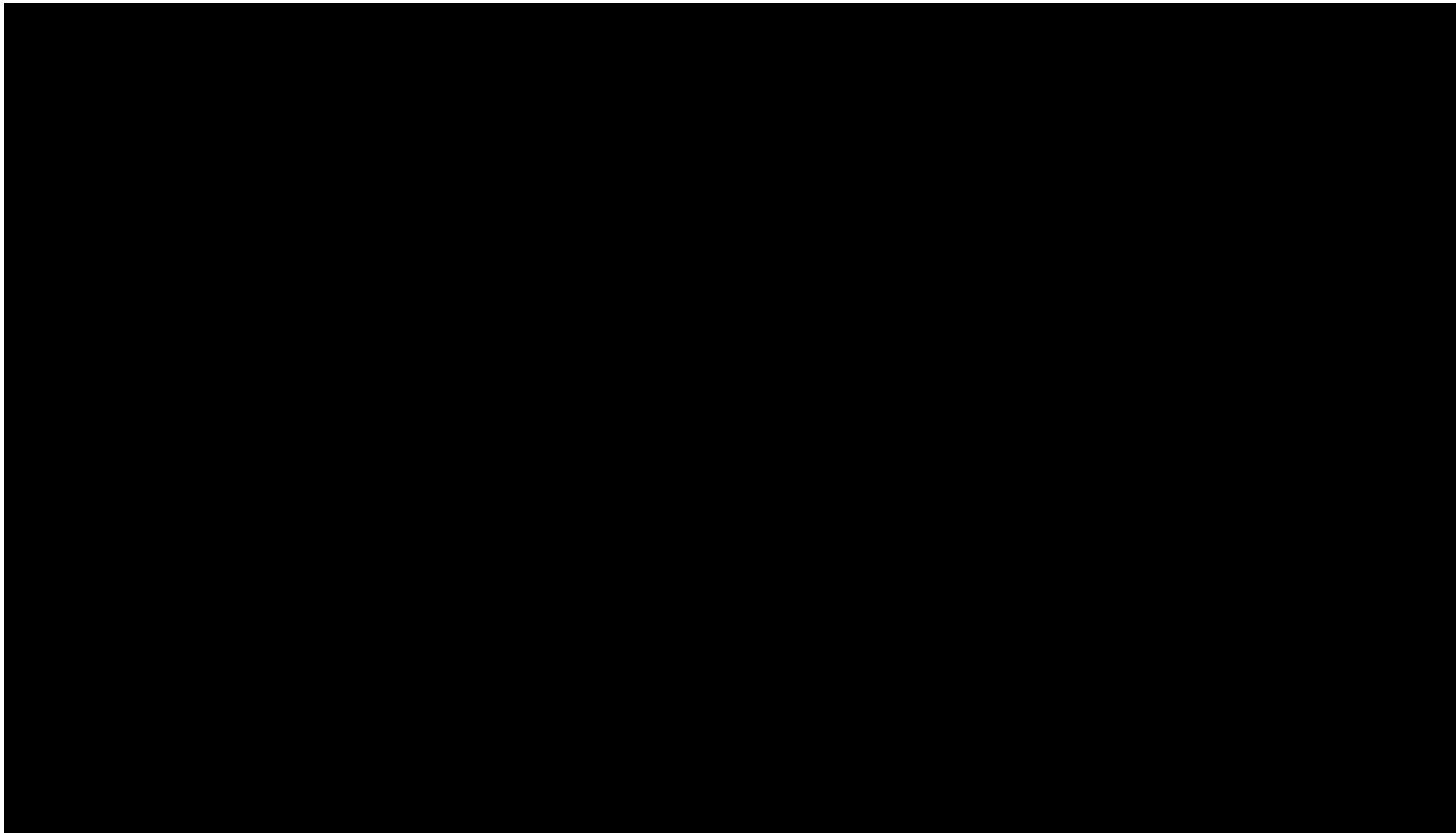
Mackinlay et al. The perspective wall: Detail and context smoothly integrated. SIGCHI ACM, 1991.

立志成才报国裕民

Example



- Maps



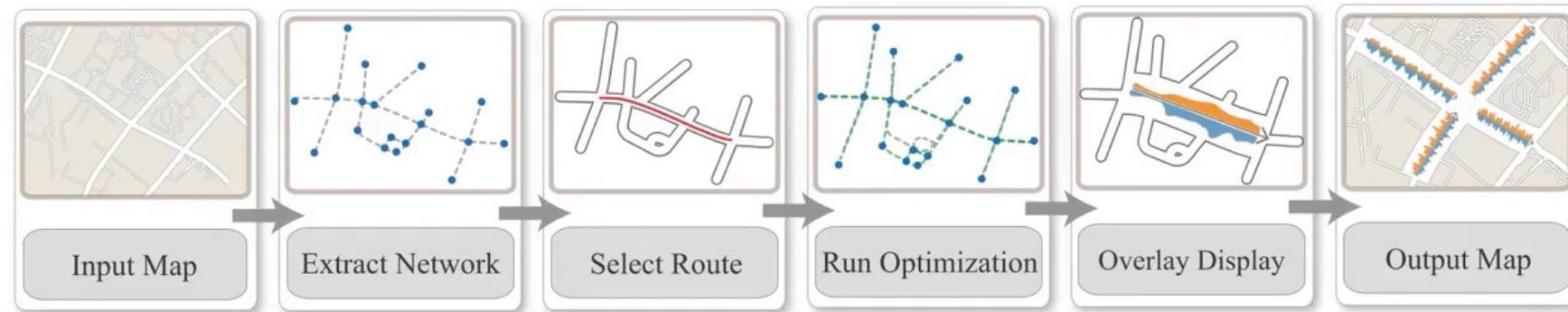
Tominski et al. 3d information visualization for time dependent data on maps. International Conference on Information Visualisation , 2005.



Example



System Overview



Sun et al. Embedding spatio-temporal information into maps by route-zooming. IEEE TVCG 2017
https://www.youtube.com/watch?v=dO_2xn6B_7c



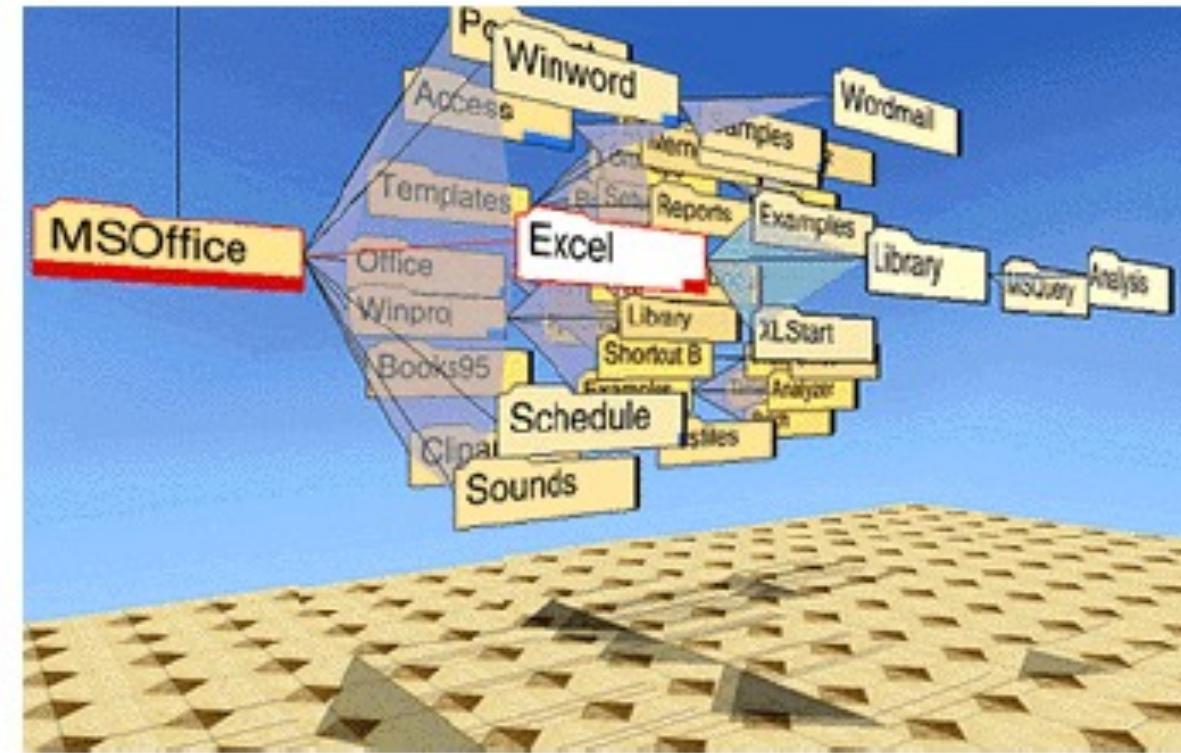
The magic volume lens



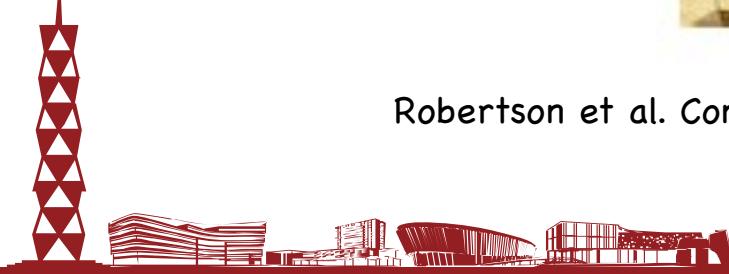
立志成才报国裕民

3D Approaches

- 3D views of hierarchies, such as file systems
 - Cone Trees



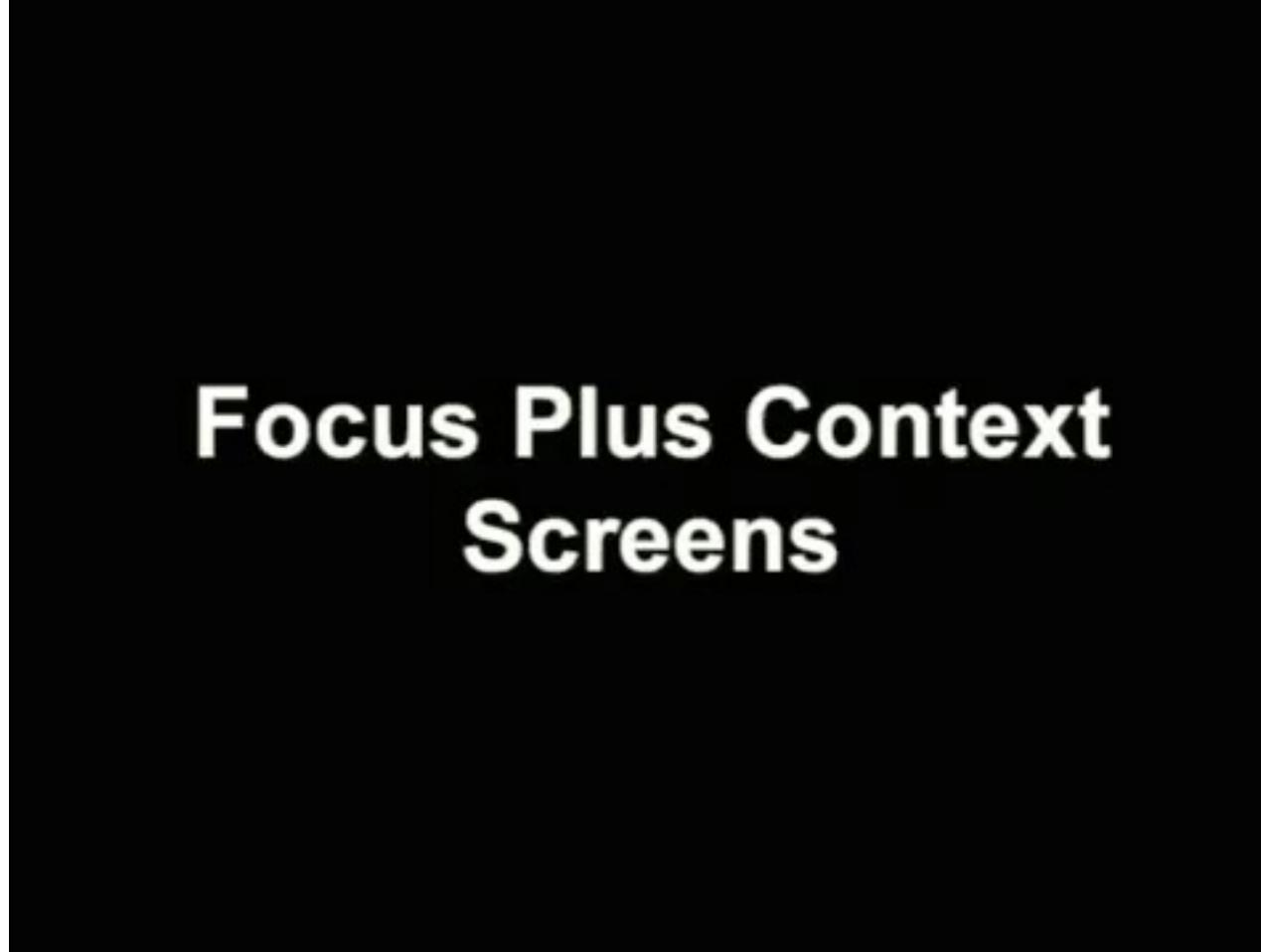
Robertson et al. Cone trees: animated 3D visualizations of hierarchical information. SIGCHI ACM, 1991.



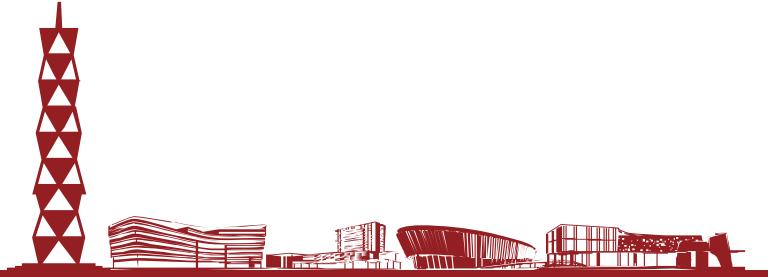
Focus & Context Screen



上海科技大学
ShanghaiTech University



<https://www.youtube.com/watch?v=b9pGHkokldk>



立志成才报国裕民



OUTLINE



- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design

Animation

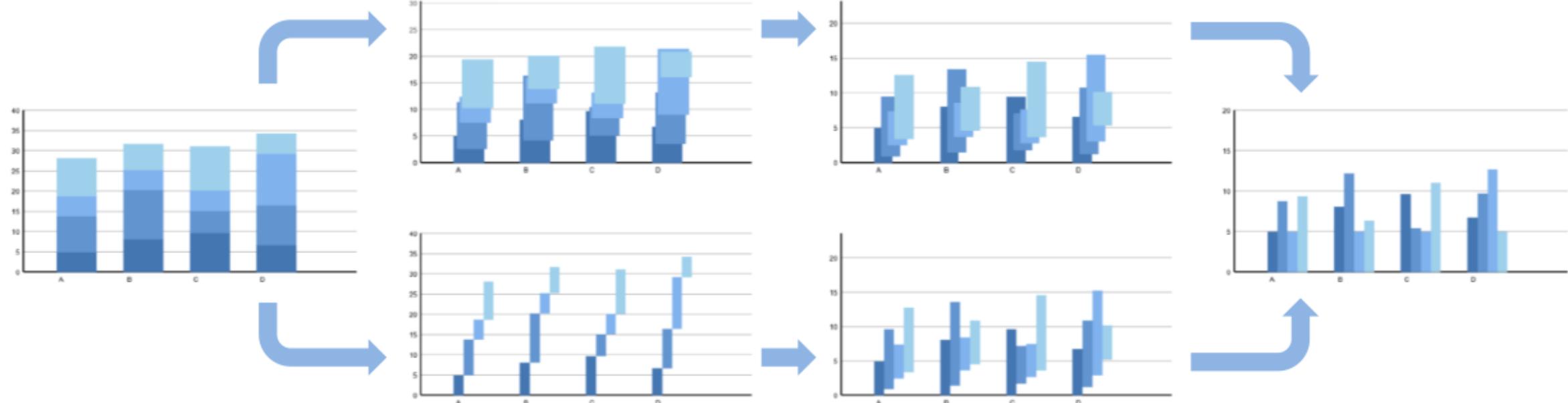
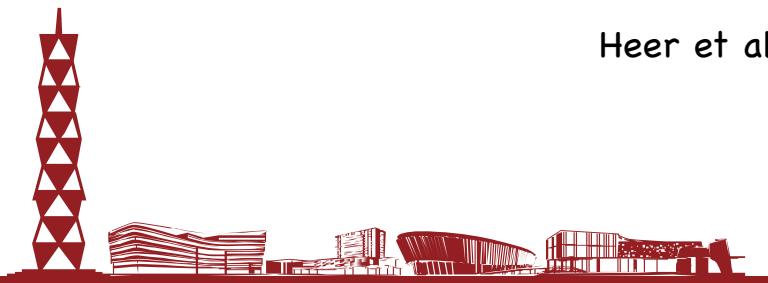


Figure 2. Animating from stacked bars to grouped bars. The top path directly interpolates between the starting and ending states. The bottom path is staged: the first stage changes the widths and x-coordinates of bars, the second stage drops the bars down to the baseline.

Heer et al. Animated transitions in statistical data graphics. IEEE TVCG 2007.

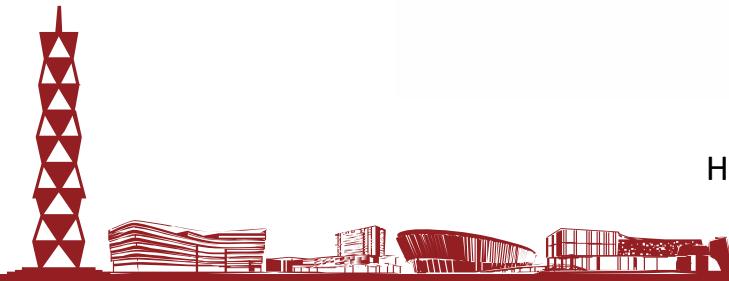




上海科技大学
ShanghaiTech University

Heer et al. Animated transitions in statistical data graphics. IEEE TVCG 2007.

<https://www.youtube.com/watch?v=vLk7mlAtEXI>



立志成才报国裕民



Animated Exploration of Graphs with Radial Layout

IEEE InfoVis 2001

Ka-Ping Yee
Rachna Dhamija
Danyel Fisher
Marti Hearst

University of California, Berkeley

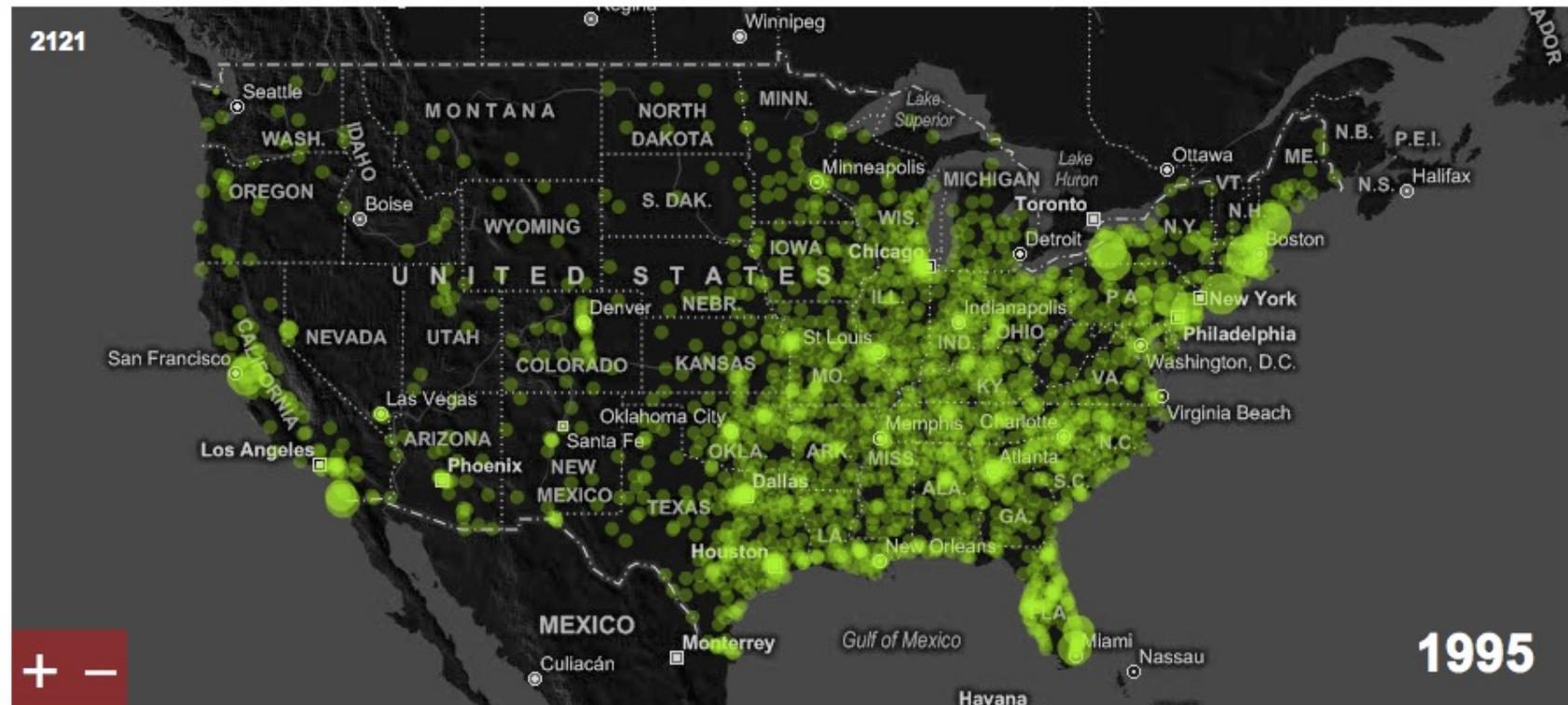
Yee, Ka-Ping. "Animated Exploration of Graphs with Radial Layout" 2001.
https://www.youtube.com/watch?v=OPX5iGro_lA



立志成才报国裕民

Watching the Growth of Walmart Across America

Over the weekend, I mapped the spread of Walmart using Modest Maps. It starts slow and then spreads like wildfire in the southeast and makes its way towards the west coast.  [Subscribe to FlowingData](#) / [Read more...](#)



<https://flowingdata.com/2010/04/07/watching-the-growth-of-walmart-now-with-100-more-sams-club/>

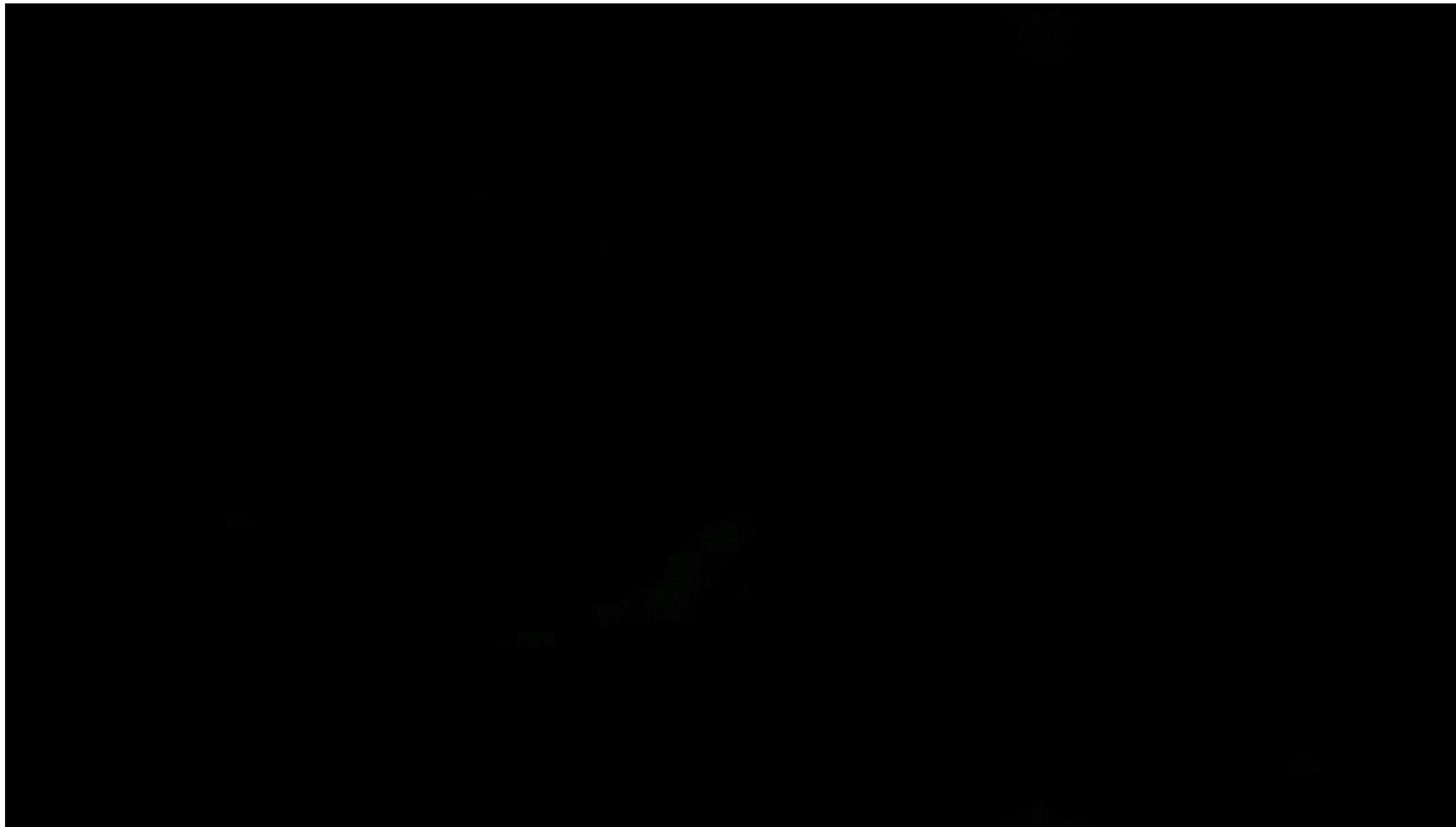




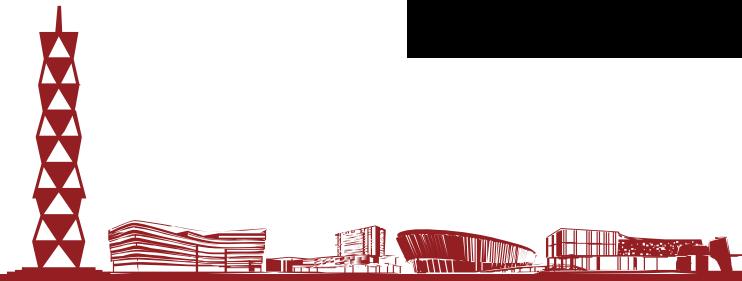
200 Countries, 200 Years, In 4 Minutes



上海科技大学
ShanghaiTech University



<https://www.youtube.com/watch?v=jbkSRLYSoj0>



立志成才报国裕民



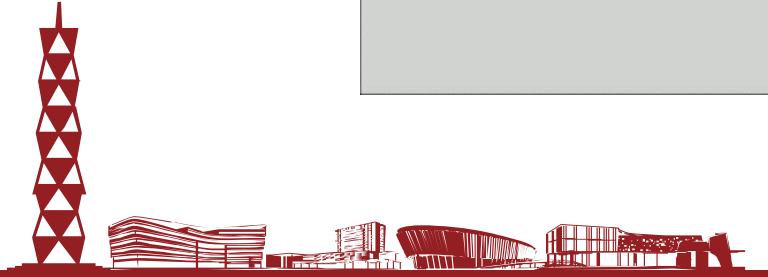
OUTLINE

- 1 Types of Interactions
- 2 Overview + Details
- 3 Focus + Context
- 4 Animation
- 5 Interaction Hardware Design





上海科技大学
ShanghaiTech University



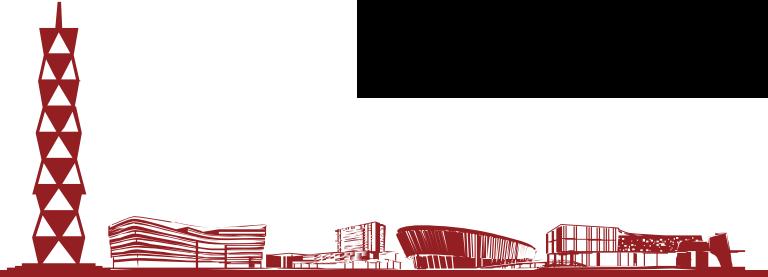
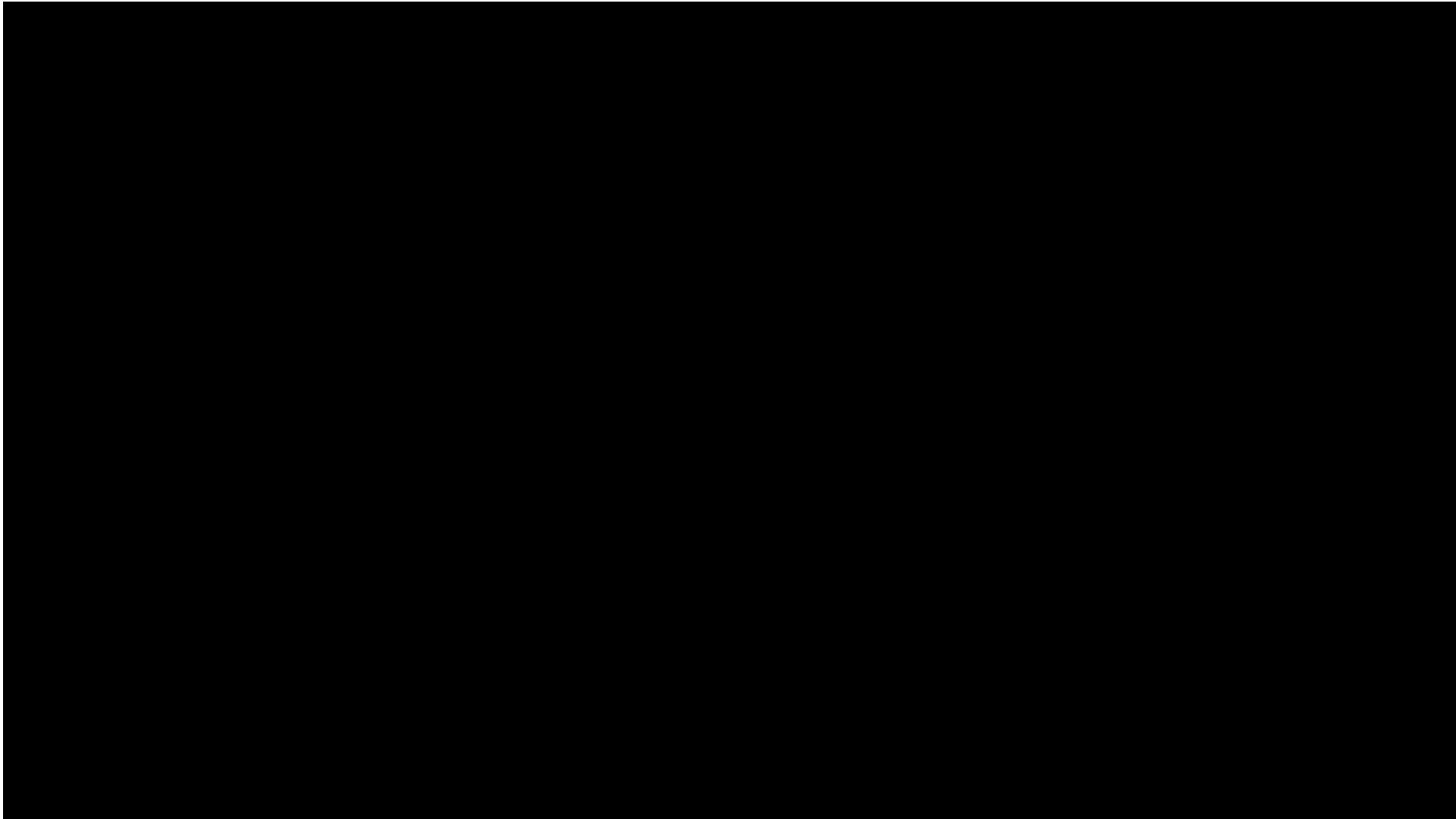
立志成才报国裕民



Multi-touch



上海科技大学
ShanghaiTech University

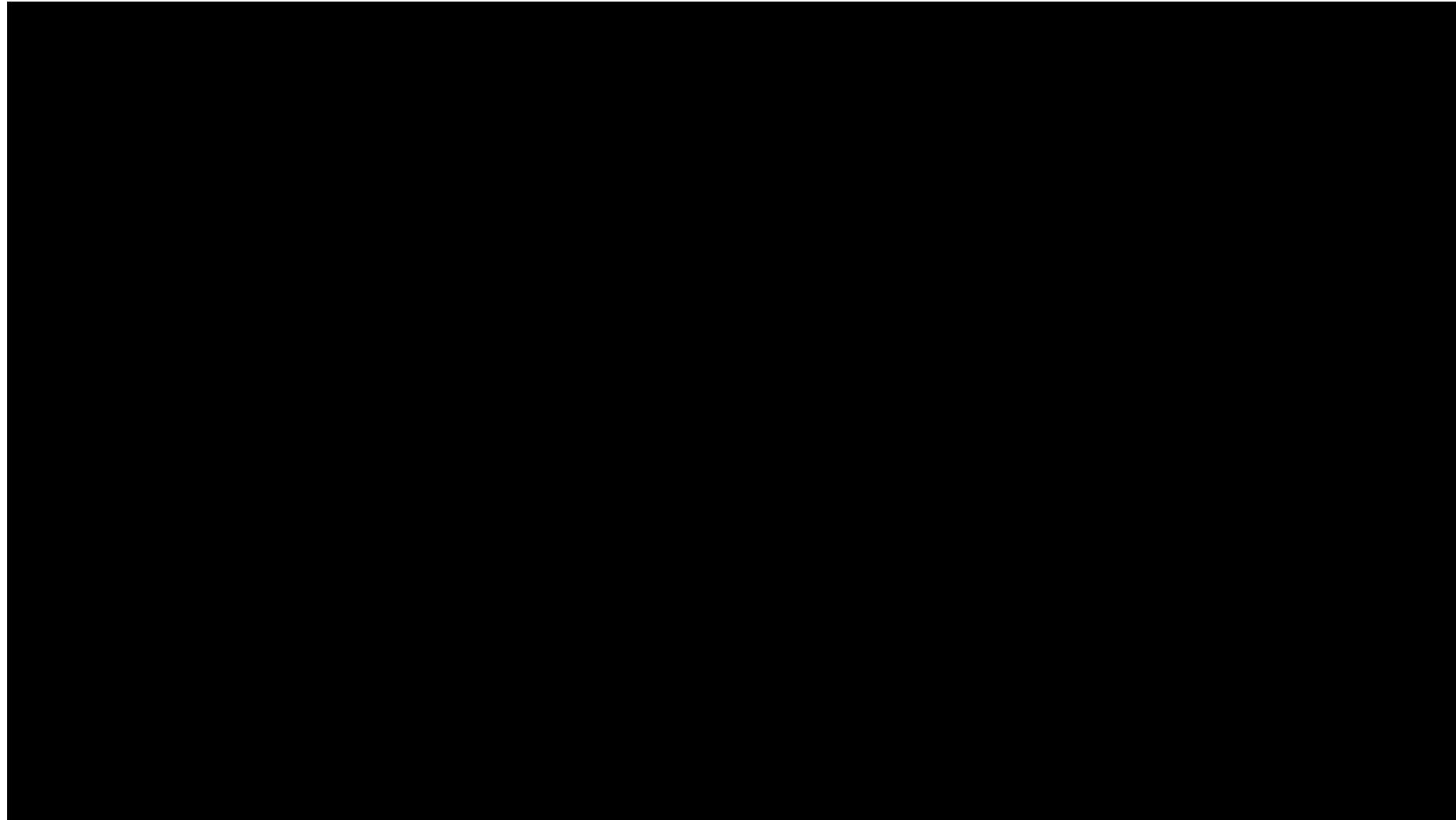


立志成才报国裕民

Microsoft Kinect



上海科技大学
ShanghaiTech University



<https://www.youtube.com/watch?v=FjY5aqz3Abg>

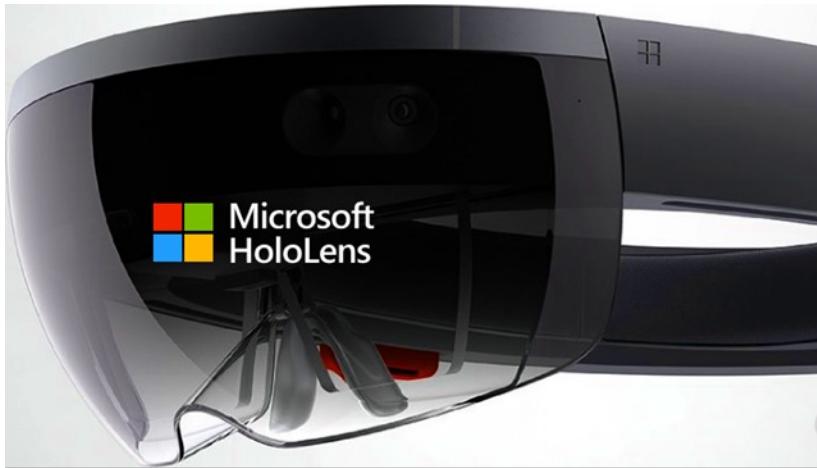


立志成才报国裕民

Microsoft HoloLens



上海科技大学
ShanghaiTech University

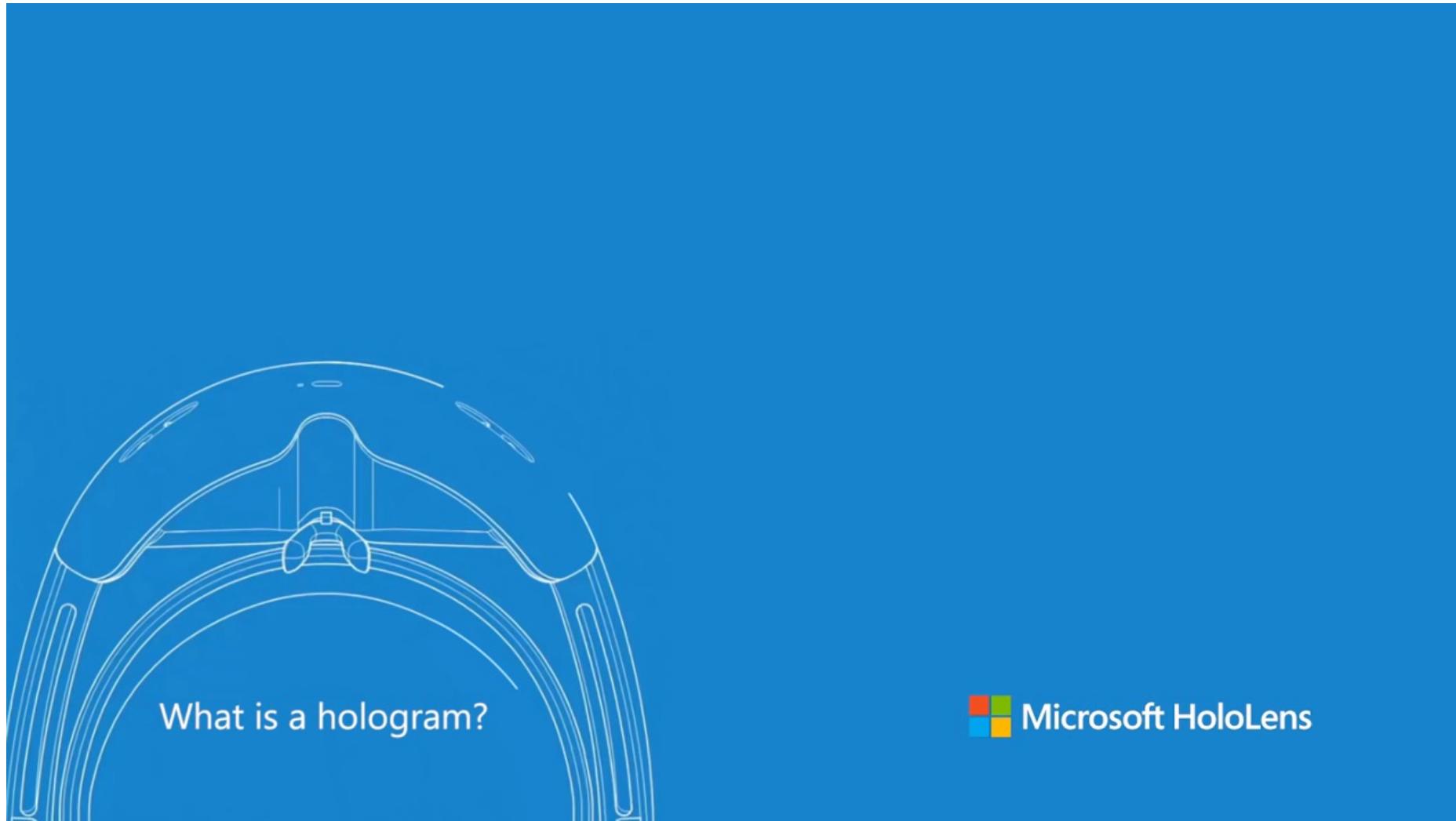


立志成才报国裕民

Microsoft HoloLens



上海科技大学
ShanghaiTech University



立志成才报国裕民



上海科技大学
ShanghaiTech University

Welcome to Glass

<https://www.youtube.com/watch?v=4EvNxWhskf8>

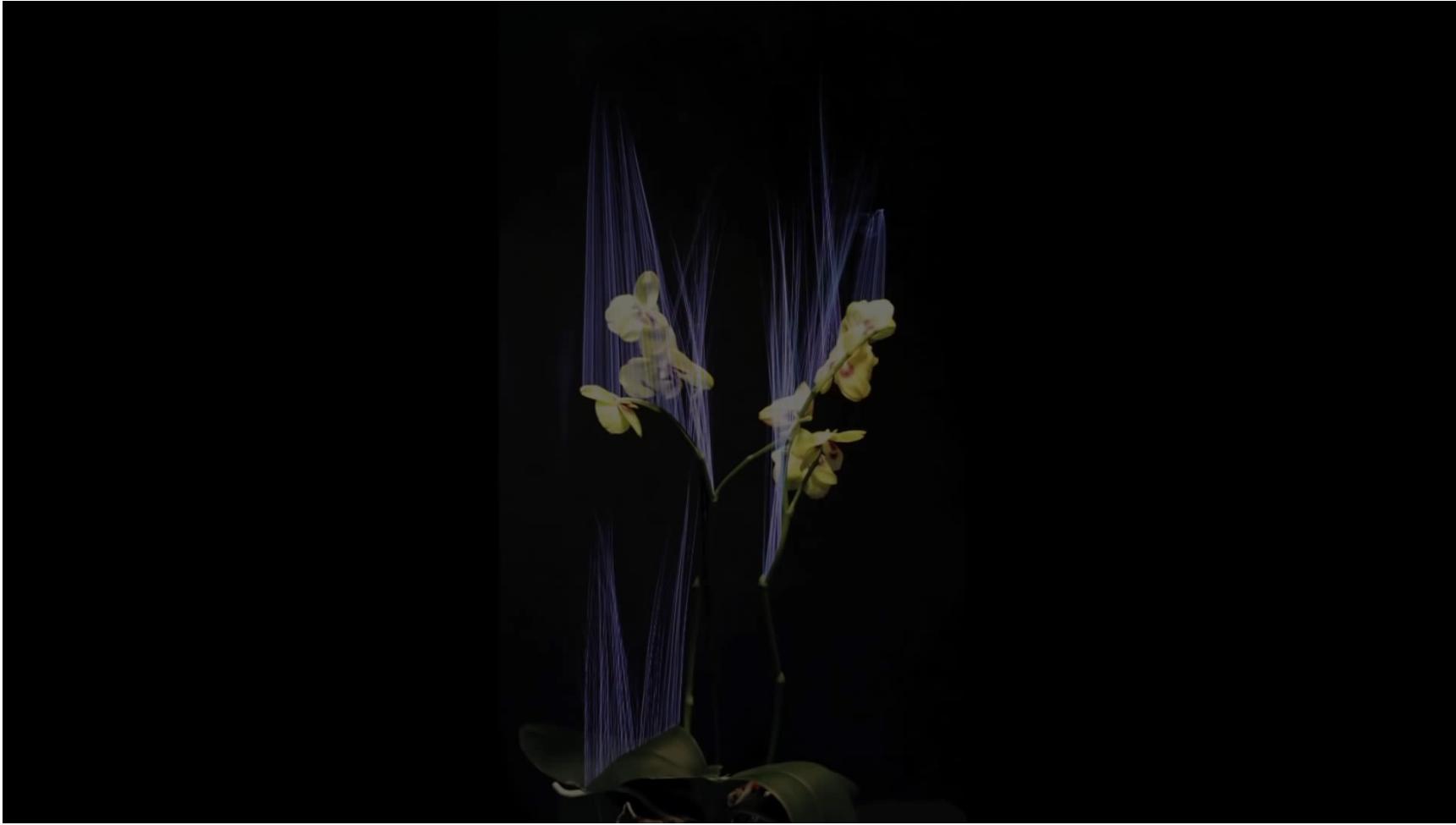


立志成才报国裕民

Interact with Plants



上海科技大学
ShanghaiTech University



Poupyrev et al. "Botanicus Interacticus: interactive plants technology." ACM SIGGRAPH 2012
https://www.youtube.com/watch?v=_uTJiEYI1ik



立志成才报国裕民

When David Meets Goliath: Combining Smartwatches with a Large Vertical Display for Visual Data Exploration

Tom Horak*, Sriram Karthik Badam*, Niklas Elmqvist, Raimund Dachselt

*The first two authors contributed equally to this work.

ACM CHI 2018
Montreal, Canada



TECHNISCHE
UNIVERSITÄT
DRESDEN



INTERACTIVE
MEDIA LAB
DRESDEN



UNIVERSITY OF
MARYLAND
1856



立志成才报国裕民



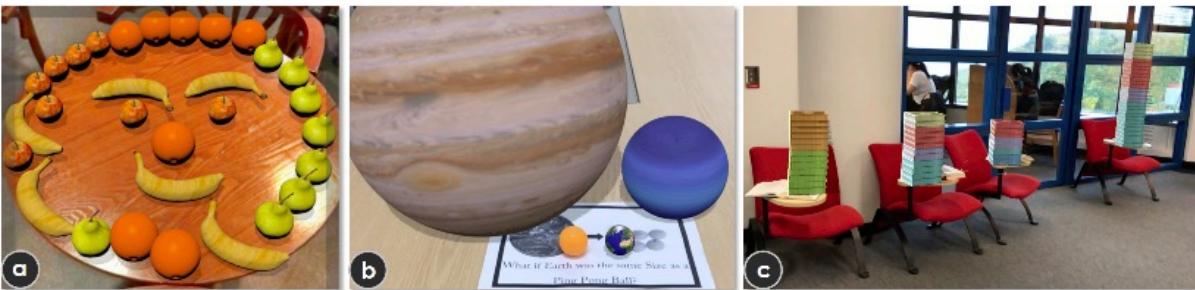
Immersive data visualization and visual analytics



Immersive Data Visualization and Visual Analytics



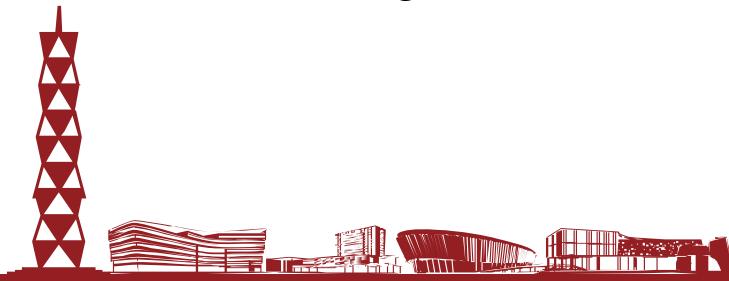
- AR + VIS
- Expands the design space of visualizations in AR, invents novel techniques that facilitate the production and interaction of visualizations beyond the desktop, and thus helps peoples cross the gap between desktop and AR platforms



In AR glyph-based visualizations, the relationship between the reality and virtuality can be a) weak, where the reality is the context; b) middle, where the reality is the reference; c) strong, where the reality is the referent.



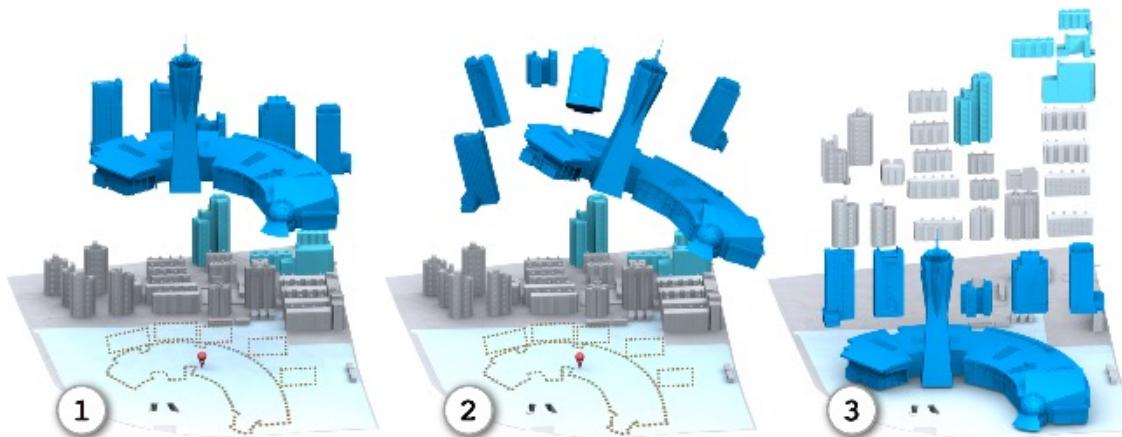
Augmenting printed visualizations can leverage the best of both physical and digital worlds: a) a journalism uses AR to extend the space of the newspaper that is limited by the banner; b) a designer uses AR to update the outdated wall-sized timeline without recreating it; c) a tourist overlays the trajectories data on a public map in AR to see his/her moving pattern



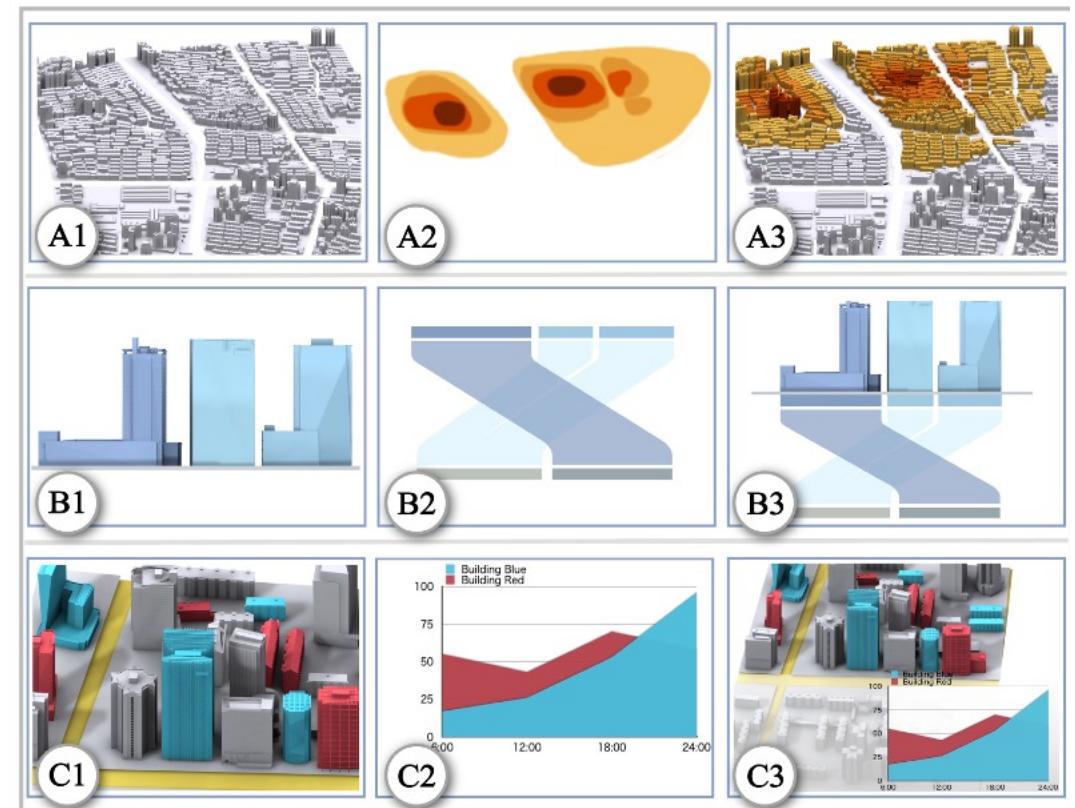
Immersive Data Visualization and Visual Analytics



- VR + VIS
- Recent advances in immersive technology, especially VR, have shed new light on 3D trajectory analysis
- VR offers benefits such as increased spatial understanding, rich semantic interaction, peripheral awareness, and large information bandwidth



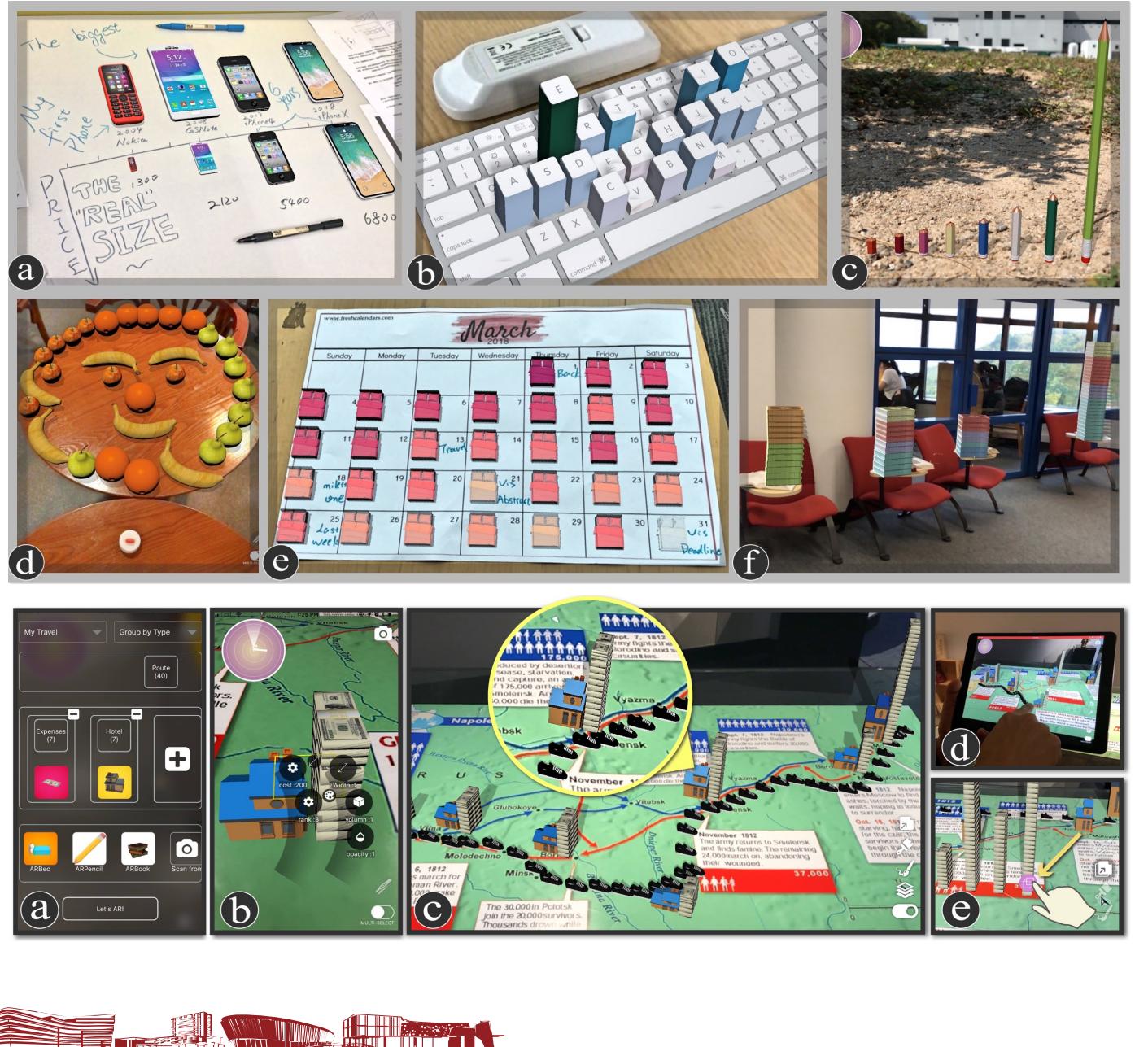
Results of different generation methods for exploded views: (1) result generated by our method, wherein the POI is shown without occlusion and the buildings are organized clearly; (2) result generated by the method based on force-directed layout [3], wherein the buildings are scattered over the air; and (3) result generated by the method based on explosion graph [12], wherein the POI is still occluded and all buildings are exploded.



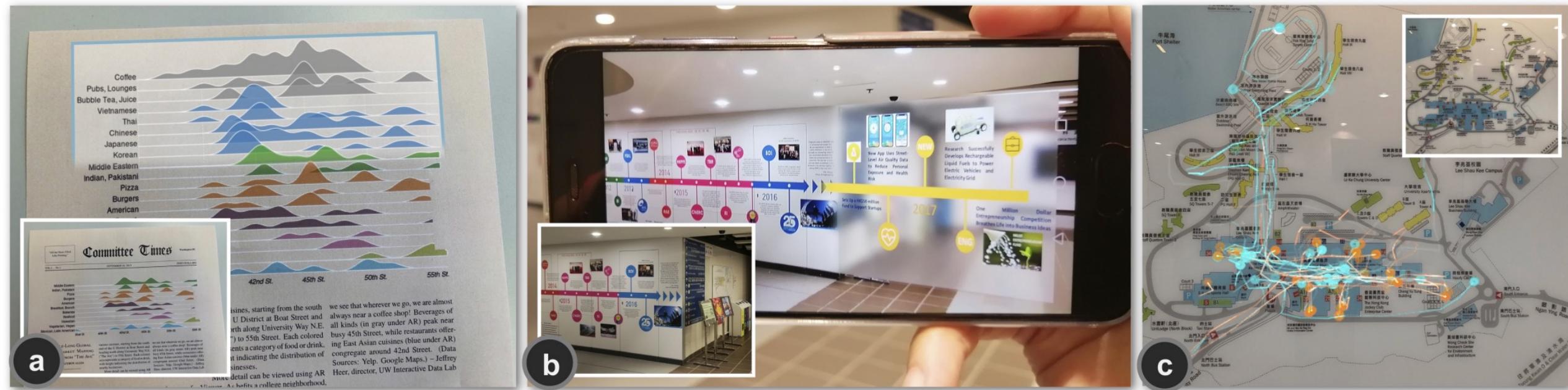
Choosing a way to visually integrate physical and abstract data based on our design considerations, namely, visual geometry and spatial distribution. Top: The situation to select the embedded view. Middle: the situation to select the mixed view. Bottom: the situation to select the linked view.



MARVisT: Authoring Glyph- based Visualizatio n in Mobile Augmented Reality

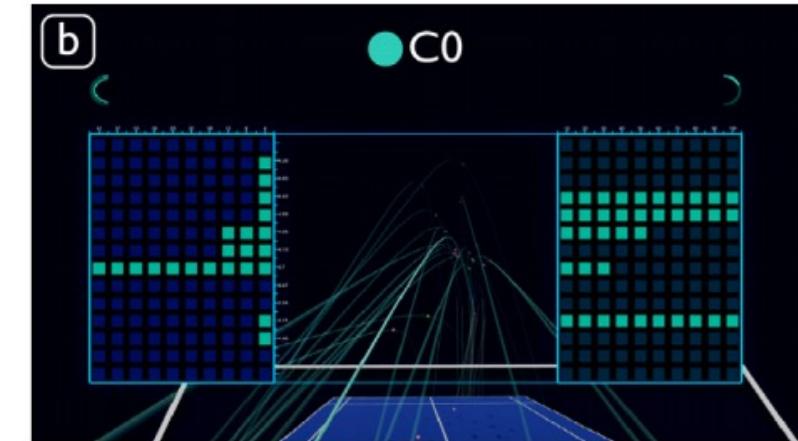
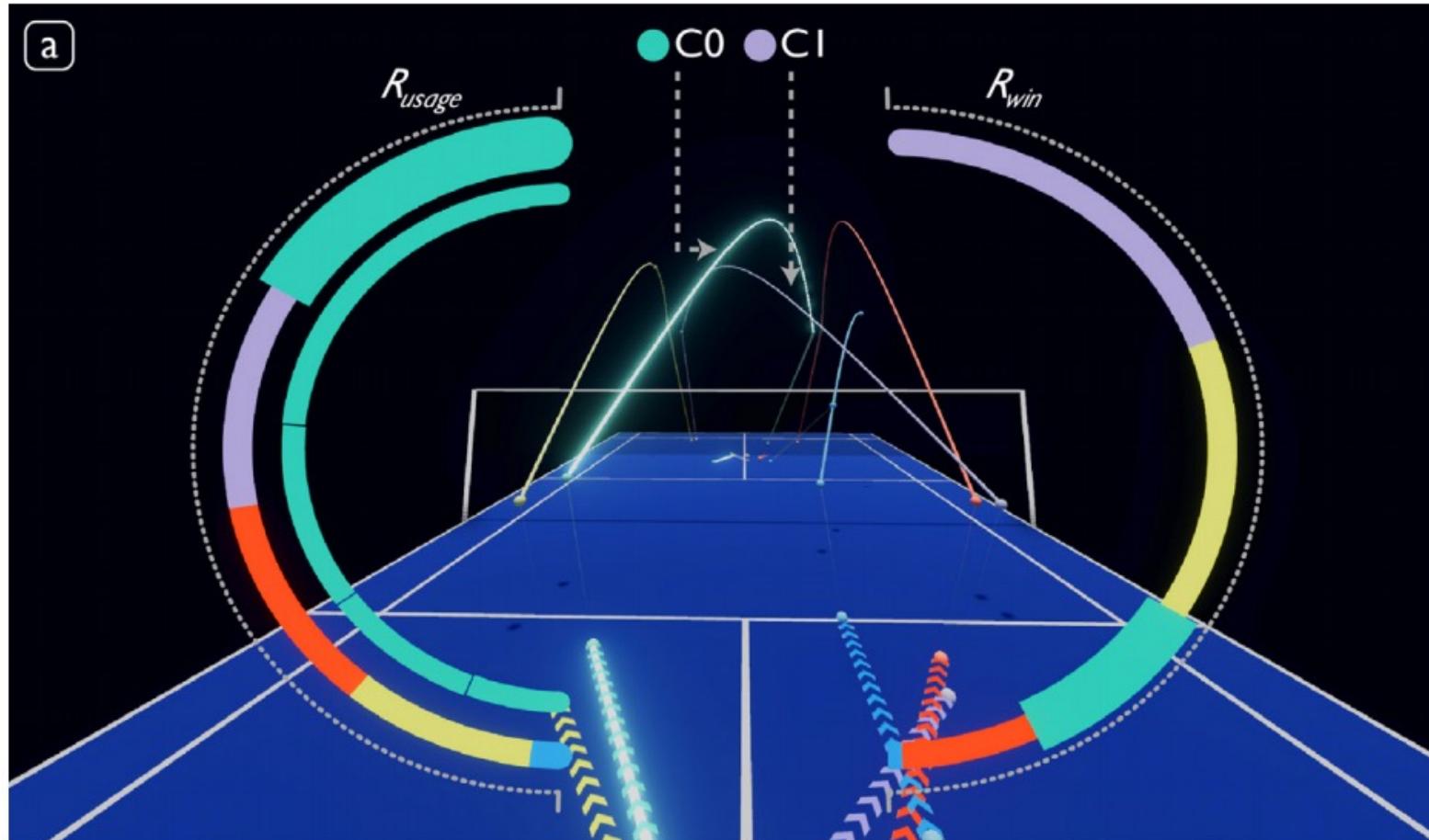


Augmenting Static Visualizations with PapARVis Designer



Augmenting static visualizations can leverage the best of both physical and digital worlds: a) a data journalism uses an augmented static visualization to extend the space of the newspaper that is limited by the banner; b) a designer uses AR to update the outdated wall-sized timeline without recreating it; c) a tourist overlays the trajectories data on a public map in AR to see his/her moving pattern.

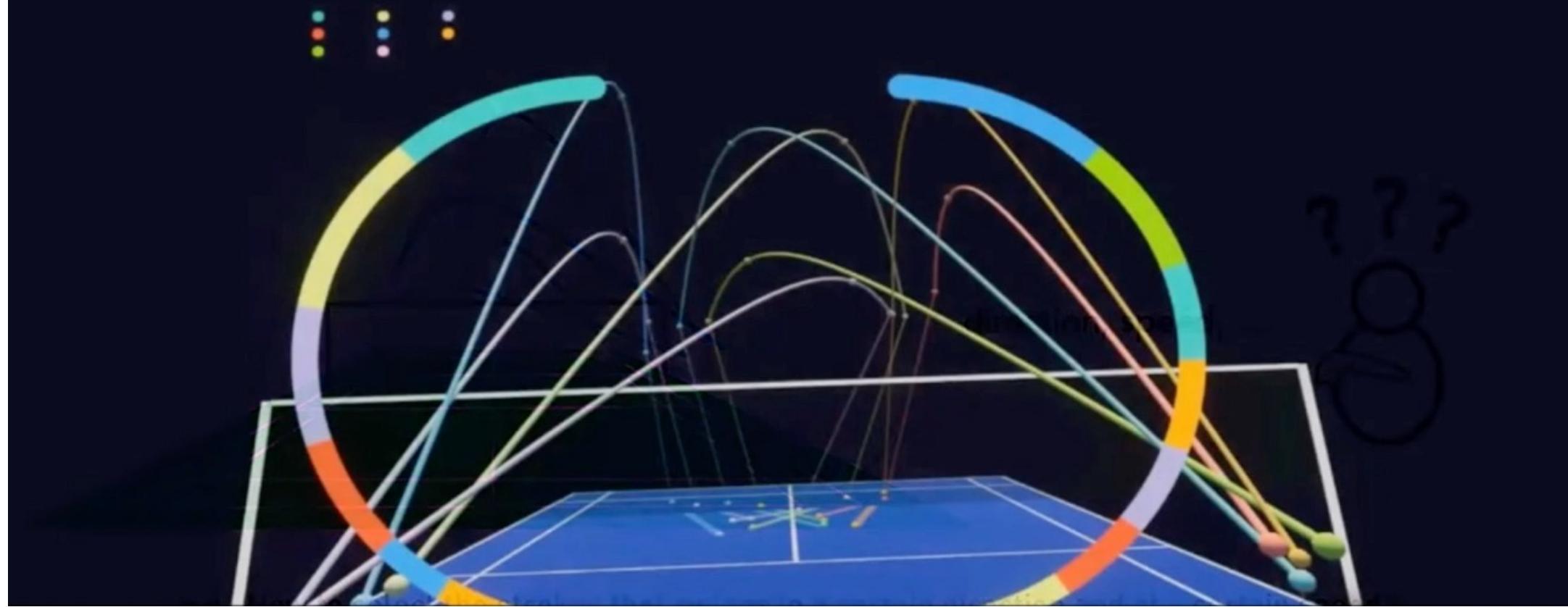
Shuttlespace: Exploring and Analyzing Movement Trajectory in Immersive Visualization





ShuttleSpace

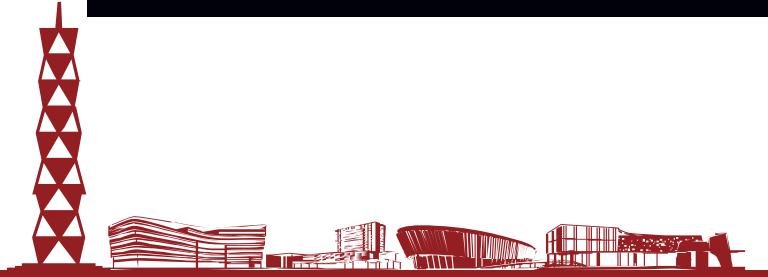
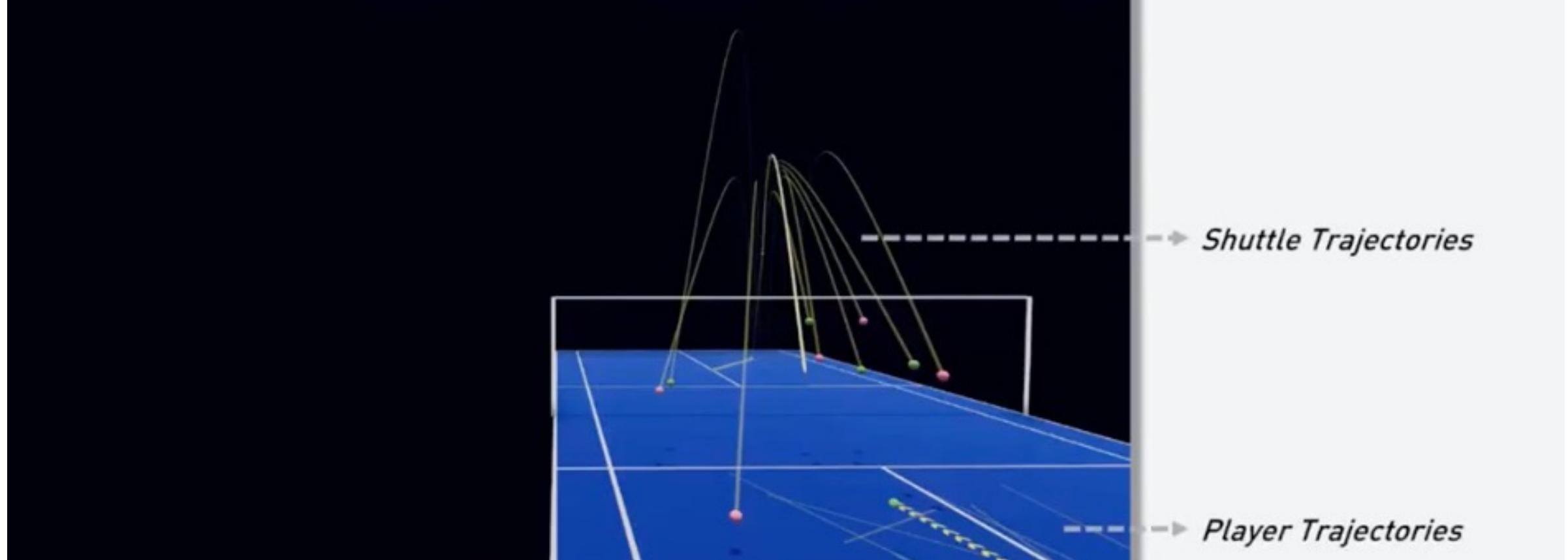
How to play badminton more efficiently and naturally? How?



First Person Perspective



1. Visualizing the data from the player's perspective

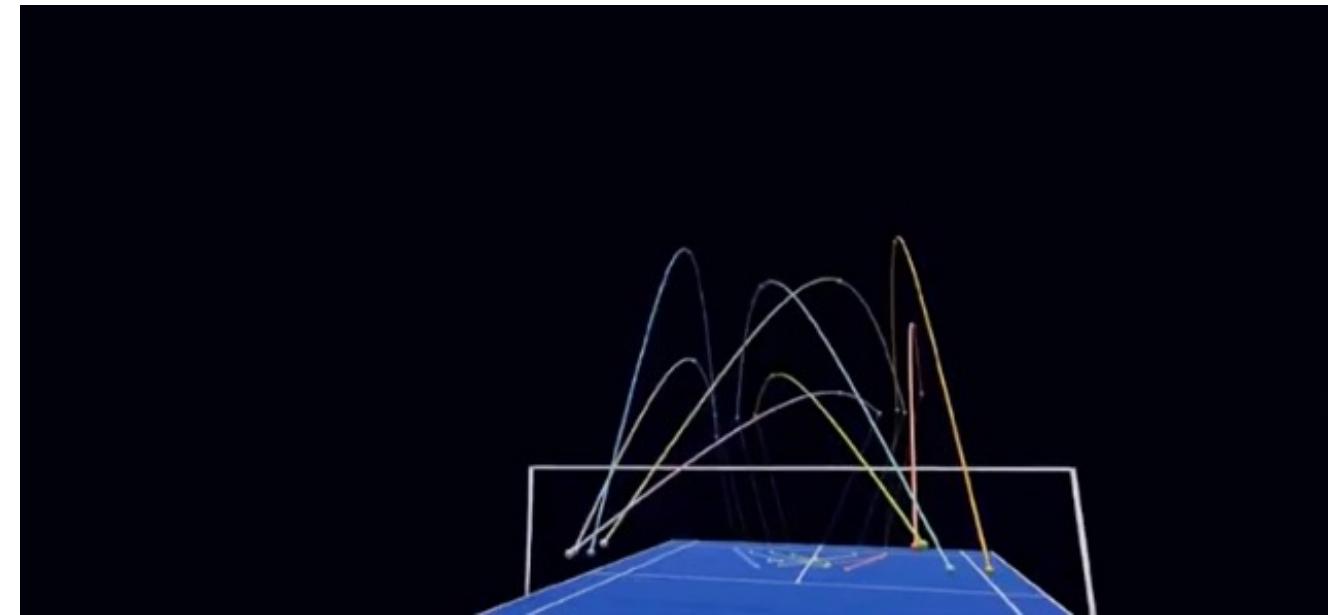
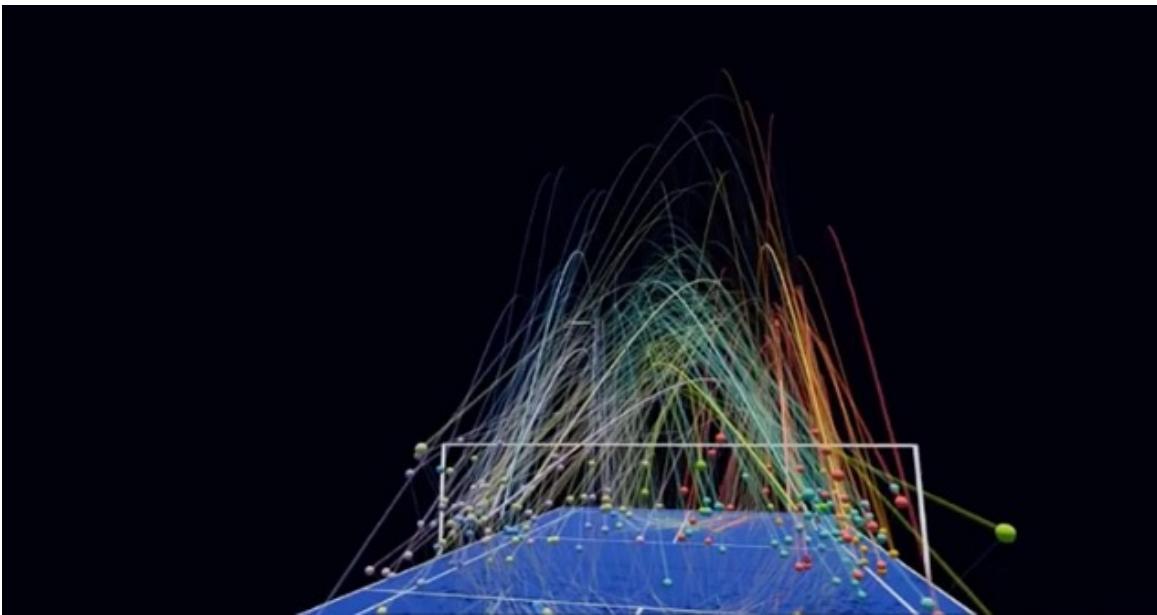


First Person Perspective



2. Allowing multi-granularity analysis of trajectory data

Examine different categories of strokes

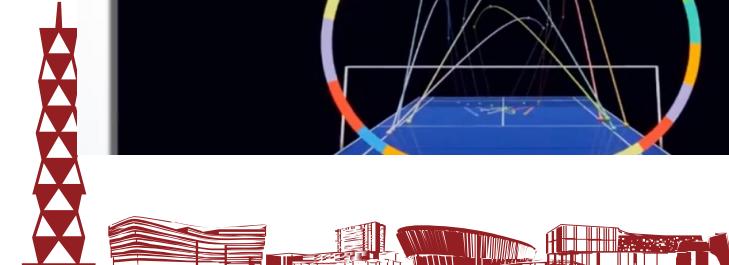
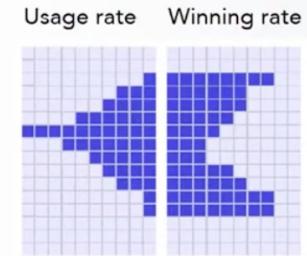
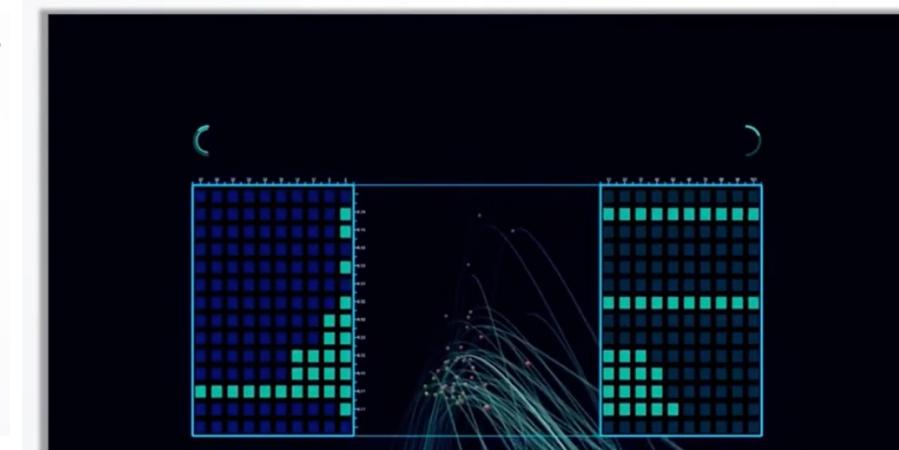
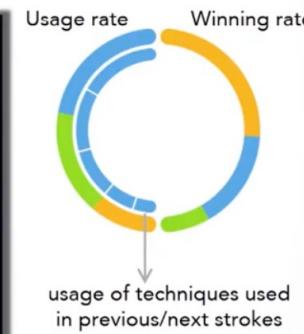
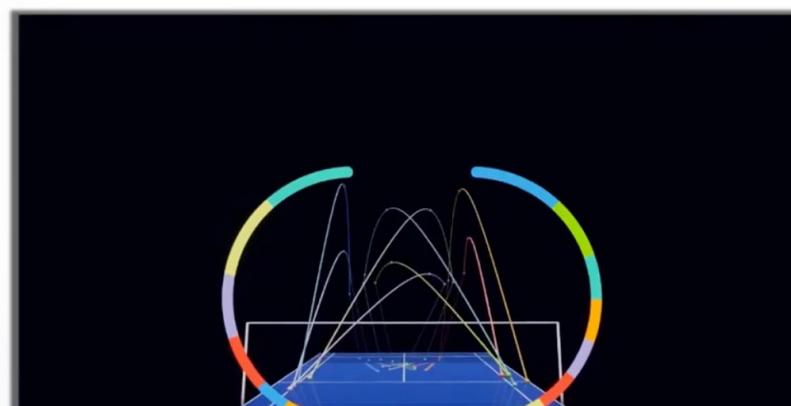
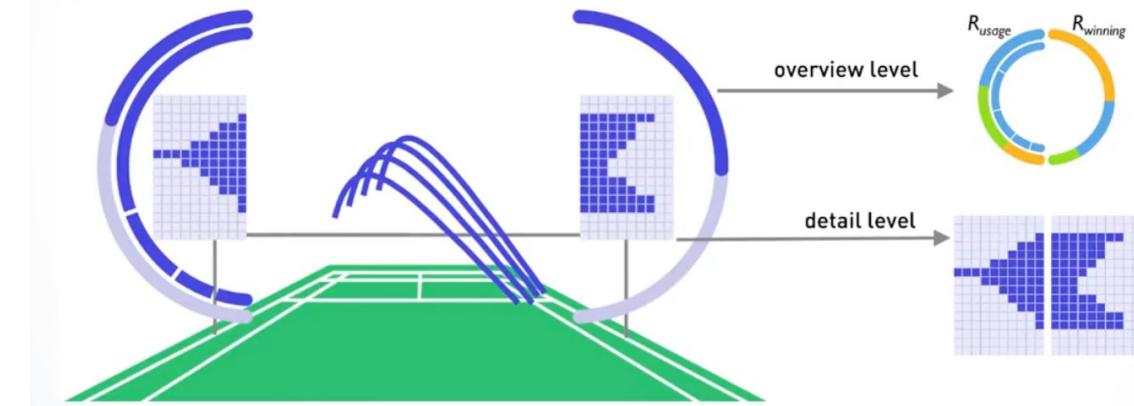
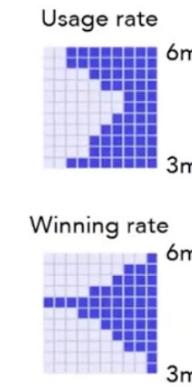
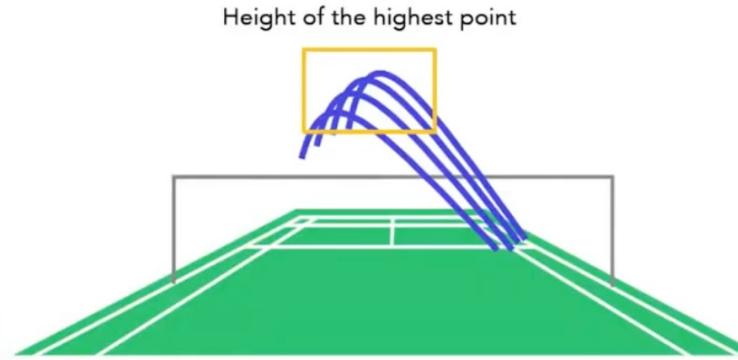


Hierarchical DBSCAN: reduce visual clutter and keep basic shape



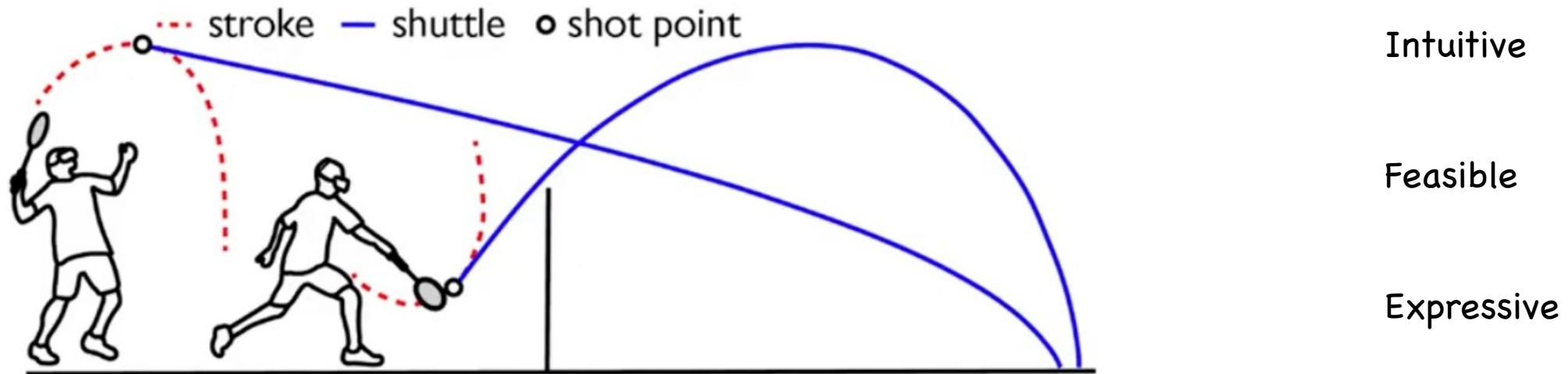
3. Supporting visual correlation analysis

Relationships between statistics and trajectory form



Natural Embodied Selection

VirtualStroke: Metaphorical interaction design



It's familiar to our domain experts that use strokes to specify trajectories

Position & Velocity → Simulating stroke trajectory → Retrieve similar trajectories



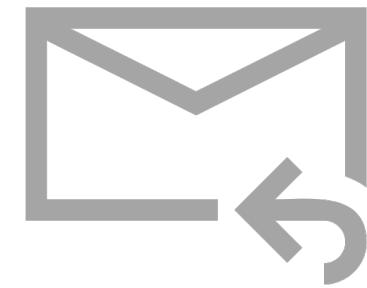
Case Study: Lob Trajectories Analysis

Next, I am going to introduce one of our case studies to demonstrate the usability of our



Quan Li

Questions?
Thank you 😊



liquan@shanghaitech.edu.cn