SC4024/CZ4124
Data Visualization

Assistant Professor WANG Yong

yong-wang@ntu.edu.sg

CCDS, Nanyang Technological University

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Chapter 8.2
Interactive Visualization

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Outline

- What is Interactive Data Visualization?
- Why is Interaction Useful for Data Visualization?
- Seven Types of General Interactions

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What is Interactive Data Visualization?

- Visible Change Under Your Control

- Unlike static charts, interactive data visualisation enables the user to further explore the dataset **by interactively manipulating** and **changing** the visual representation of all or a selected subset of the data using appropriate interaction techniques and input devices.

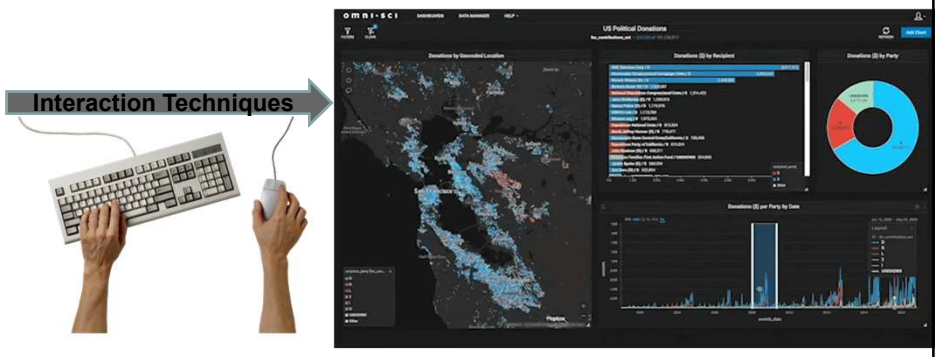

Image from: OmniSci, Interactive Data Visualization Definition - https://www.omnisci.com/technical-glossary/interactive-data-visualization

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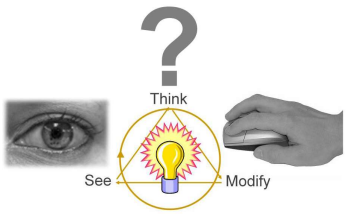
Why is Interaction Useful for Data Visualization?

- It is an essential requirement of data visualization



- Ben Shneiderman's mantra:

"*Overview first, zoom and filter, then details-on-demand*"

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

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Why is Interactive Data Visualization Useful?

- Some benefits

- Interactive visualisation is useful when the dataset is **large** and is embedded with **complex data insights** which have yet to be verified or uncovered.

- **Identify relationships** more effectively - by selectively focusing on specific metrics so that non-obvious cause-and-effect relationships within the data can be seen.

-**Identify trends** and **patterns** faster – by having the ability to visualise complex data at varying scales and in decluttered views by using only a selective data subsets.

- **Telling data stories** more convincingly – by presenting a sequenced and focused narrative through the ability to zoom in/out, highlight relevant information, filter, and change the parameters to present multiple viewpoints of the data.

Image from: OmniSci, Interactive Data Visualization Definition - https://www.omnisci.com/technical-glossary/interactive-data-visualization

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7 General Categories of Interactions

- *Select:* mark something as interesting
- *Explore:* show me something else
- *Reconfigure:* show me a different arrangement
- *Encode:* show me a different representation
- *Abstract/Elaborate:* show me more or less details
- *Filter*: show me something conditionally
- *Connect*: show me related items

Yi, Ji Soo, et al. "Toward a deeper understanding of the role of interaction in information visualization." TVCG, 2007.

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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 a bar in a histogram
- Select a set of points by brushing

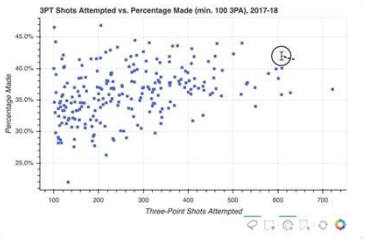

Image from: Leon D'Angio @ Realphython.com - Interactive Data Visualization in Python With Bokeh - https://realpython.com/python-data-visualization-bokeh/#selecting-data-points

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Selection Functions

- ***Pointer*** selects a single object in a plot.
- ***Drag-box*** selects a rectangular region in a box.
- ***Brush*** is a generalisation of the drag-box. Once a rectangular region is defined, the brush allows users to move that region across a plot and thus dynamically change the selected subset.
- ***Slicer*** is an axis-parallel selection tool, which selects a range along an axis, where the end-point of the interval can be modified dynamically.
- ***Lasso*** allows users to define an arbitrary contiguous shape to select data.

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Explore

"Show me something different"

- Exploration enables users to examine a different subset of data
- Exploration overcomes the limitation of display size

Examples

- Panning in Google Earth
- Direct Walking in Visual Thesaurus

Visual Thesaurus: https://www.visualthesaurus.com/app/view

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Explore: More Examples

2D Navigation: MatrixWave [1]

3D Navigation: Interactive visualization of scanned mummies [2]

[1] Zhao et al. MatrixWave: Visual comparison of event sequence data. ACM HFCS, 2015. https://www.youtube.com/watch?v=HranxBG9F_w
[2] Ynnerman, et al. "Interactive visualization of 3D scanned mummies at public venues." ACM Communications, 2016. https://www.youtube.com/watch?v=tI_sJuA2LWg

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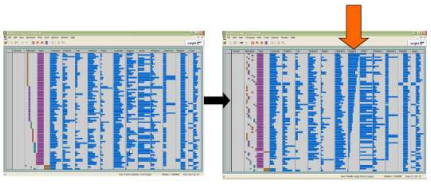
Reconfigure

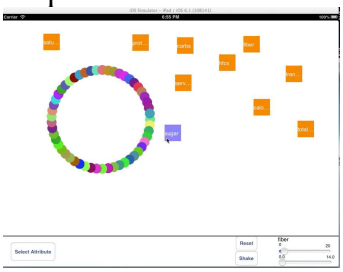
"Show me a different arrangement"

- Reconfiguring provides different perspectives by changing the spatial arrangement of representation

Examples

- Sorting data with respect to a particular attribute
- Changing the attributes in a scatter plot
- Reposition the visual elements





Yi, et al, Dust & Magnet: multivariate information visualization using a magnet metaphor. IEEE https://www.youtube.com/watch?v=laGJ4v7DEU0

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Encode

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"Show me a different representation"

- Change visual appearances

Examples

- Change color encoding
- Change size
- Change orientation
- Change font
- Change shape

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

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Encode

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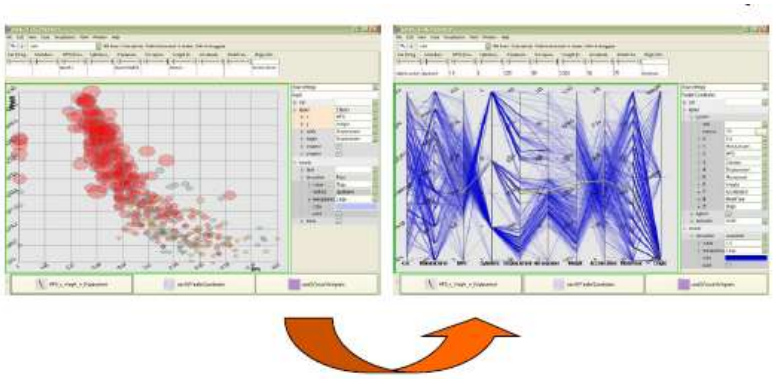
- Example: Select a different representation



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Abstract/Elaborate

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"Show me more or less detail"

- Adjust the level of abstraction (overview and details)

Examples

- Drill-down in Treemap

  https://observablehq.com/@d3/zoomable-treemap

- Zooming

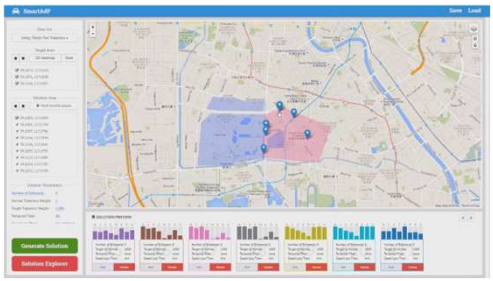

Image from: SmartAdP: Visual Analytics of Large-scale Taxi Trajectories for Selecting Billboard Locations. https://www.youtube.com/watch?v=7vkYubflVuo

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Filter

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"Show me something conditionally"

- Change the set of data items being presented based on some specific conditions

Examples

- Attribute based filtering
- Dynamic query

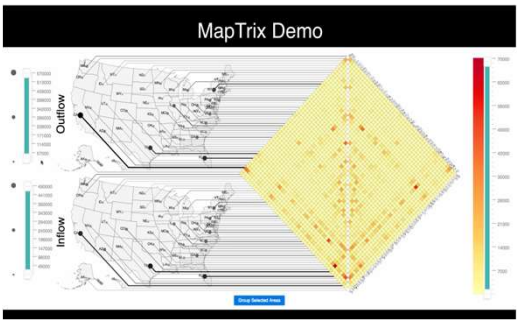

Image from: MapTrix Interactions. https://www.youtube.com/watch?v=kc1PP4J9BH8

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Connect

"Show me related items"

- Highlight associations and relationships
- Show hidden data items that are relevant to a specified item

Examples

- Linking the relevant items in SmartAdp and *Vizster*

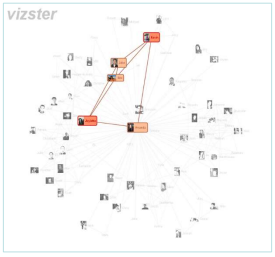

Image from: SmartAdP: Visual Analytics of Large-scale Taxi Trajectories for Selecting Billboard Locations. https://www.youtube.com/watch?v=7vkYubflVuo
Vizster: Visualizing Online Social Networks. https://www.youtube.com/watch?v=UxsACr2d-iA

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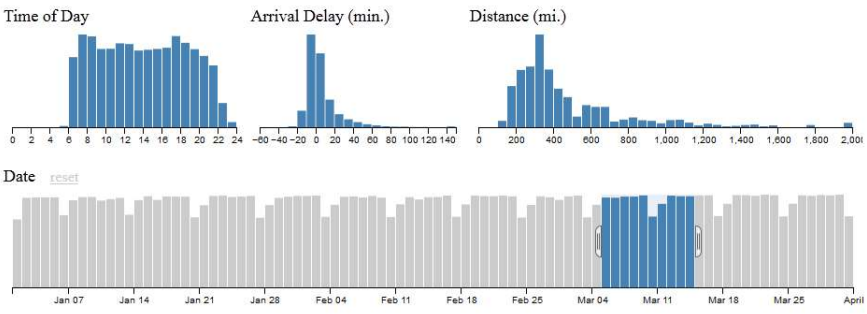
Connect: Linked Multiple Views (Demo)



March 14, 2001

26,093 of 231,083 flights selected.

04:38 PM	ONT	SMF	389 mi.	+3 min.
11:50 PM	MDW	BWI	611 mi.	+186 min.
11:50 PM	MCI	MDW	405 mi.	−10 min.
11:49 PM	STL	MDW	251 mi.	+45 min.

Demo Link:
https://square.github.io/crossfilter/

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Summary

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- Interaction is an essential part of data visualization, which provides users more flexibility and control to explore the data of their interest.
- Without interaction, a visualization technique or system becomes a static image or autonomously animated images, limiting the usefulness of data visualization with the increase of dataset size and dimensions.
- You are recommended to enable necessary interactions in your own visualization approaches or systems!

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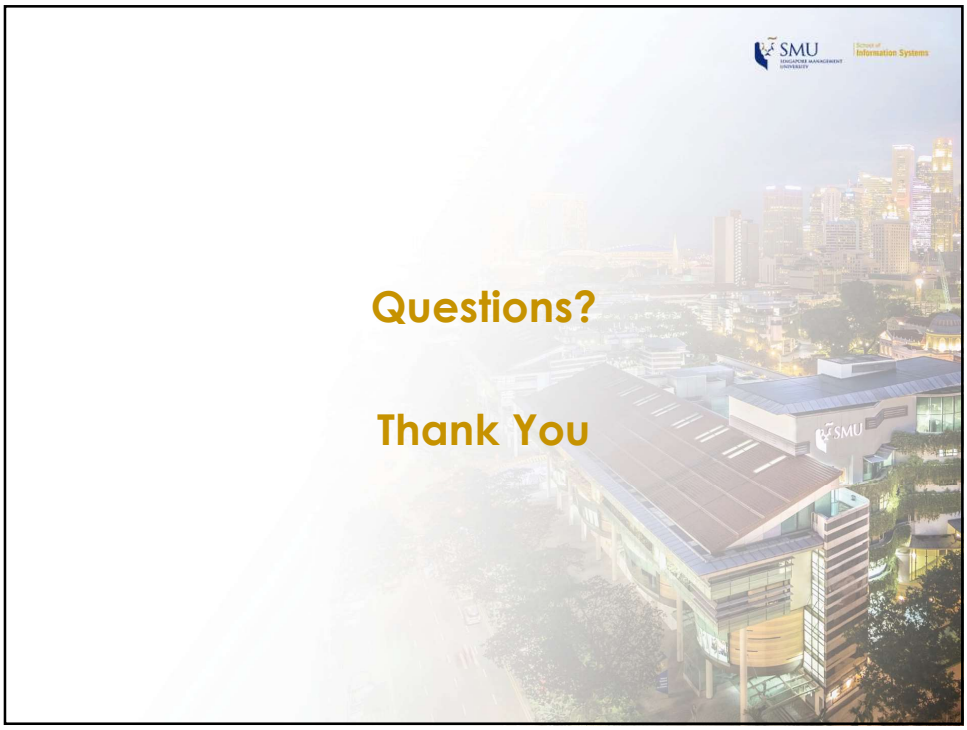

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Interesting Data Visualizations

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- https://public.tableau.com/en-us/gallery/?tab=viz-of-the-day&type=viz-of-the-day
- https://bost.ocks.org/mike/
- https://archive.nytimes.com/www.nytimes.com/interactive/2013/04/08/business/global/asia-map.html

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