

Lesson 3

Core Skills for Visual Analytics

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What will you learn from this lesson?

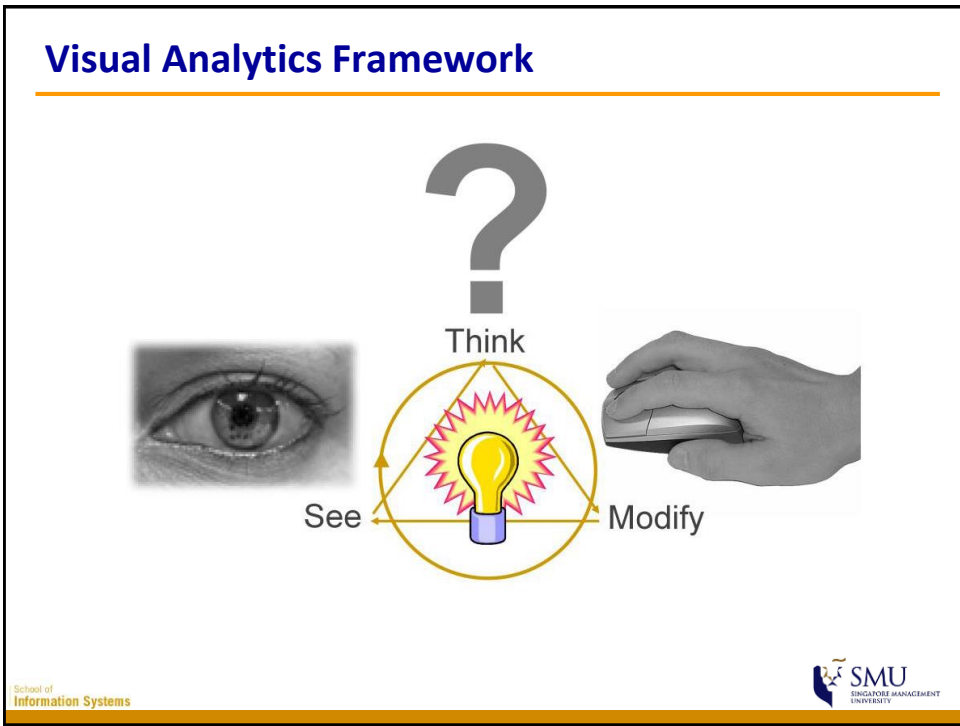
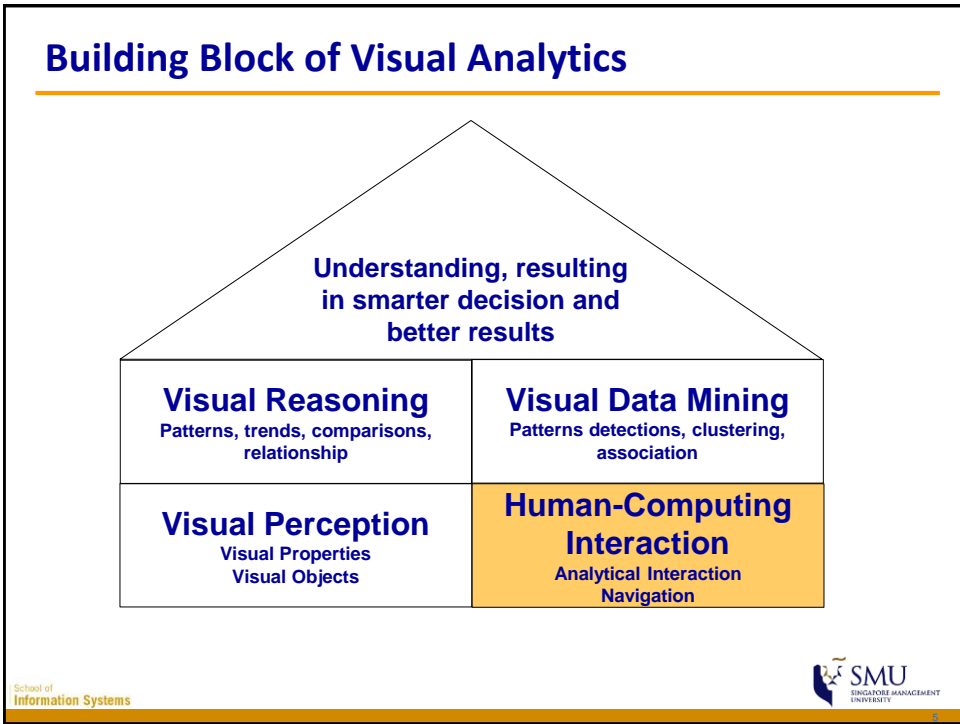
- Aptitudes and Attitudes of effective visual analytics
- Interactive analytics techniques
- The concept of linked multiple views
- Principles for animation and a taxonomy of transition types
- Design consideration for animated data visualisation

Visual Analytics Skills

- Simplify - good data visualization captures the essence of data - without oversimplifying.
- Compare - we can't hold the details of our data visualizations in our memory - shift the burden of effort to our eyes.
- Attend - the tool needs to make it easy for us to attend to the data that's really important.
- Explore – a visualization tools not just to answer a specific question, but to explore data and discover things.

Visual Analytics Skills

- View Diversely - to be able to look at the same data from different perspectives at the same time and see how they fit together.
- Ask why - more than knowing "what's happening", we need to know "why it's happening".
- Be skeptical - to ask more questions, as fast as we can think of them.
- Respond - to share our data that leads to global enlightenment.



Interactive Analytical Best Practices

- Shneiderman's mantra:

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

7 General Categories of Interaction Techniques

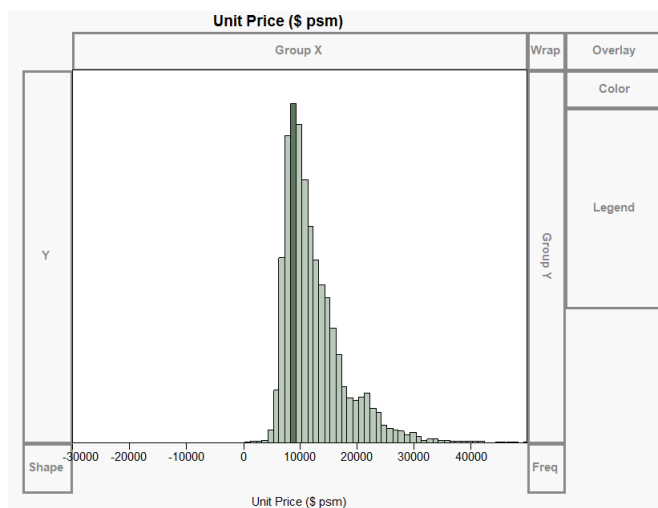
- *Select*: mark something as interesting
- *Explore*: show me something else
- *Reconfigure*: show me a different arrangement
- *Encode*: show me a different representation
- *Abstract/Elaborate*: show me more or less detail
- *Filter*: show me something conditionally
- *Connect*: show me related items

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 define, 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.

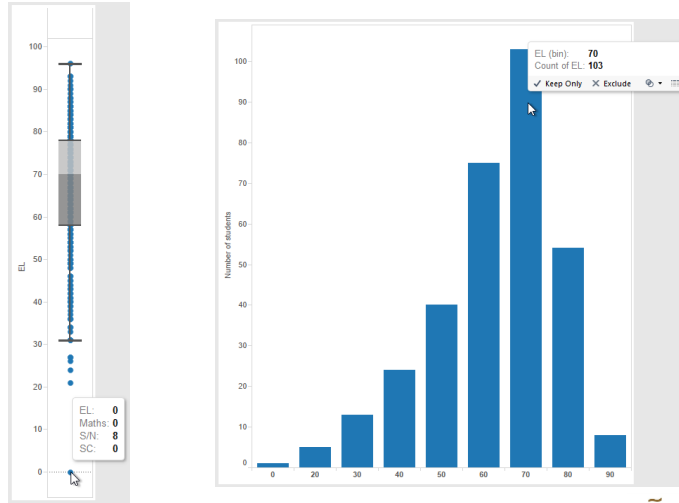
Selection: Pointer

- Selecting a single point using JMP's Arrow tool



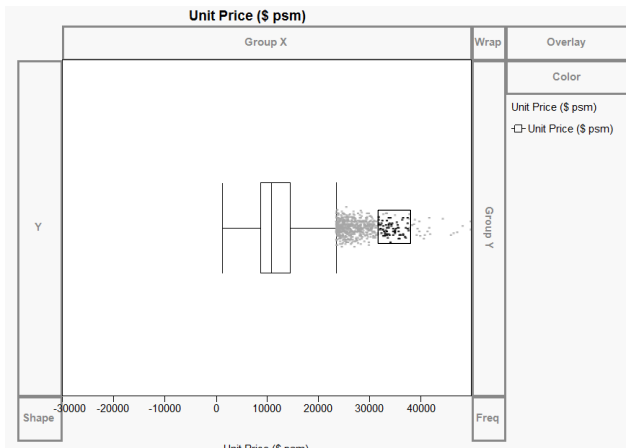
Selection: Pointer

- Selecting a single data point.



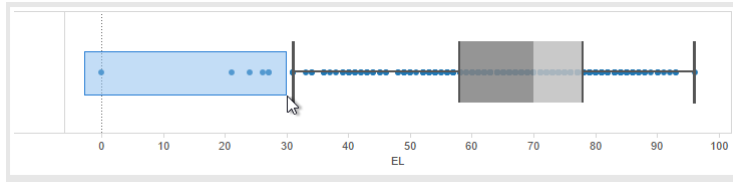
Selection: Brush

- Selecting a group of data points using JMP's Brush tool.



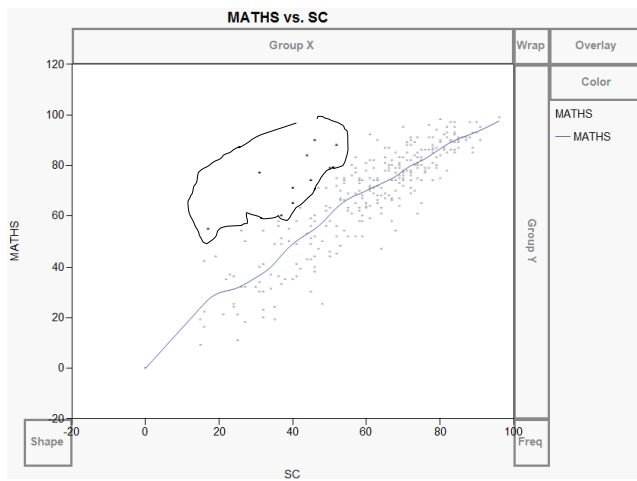
Selection: Brush

- Selecting a group of data points.

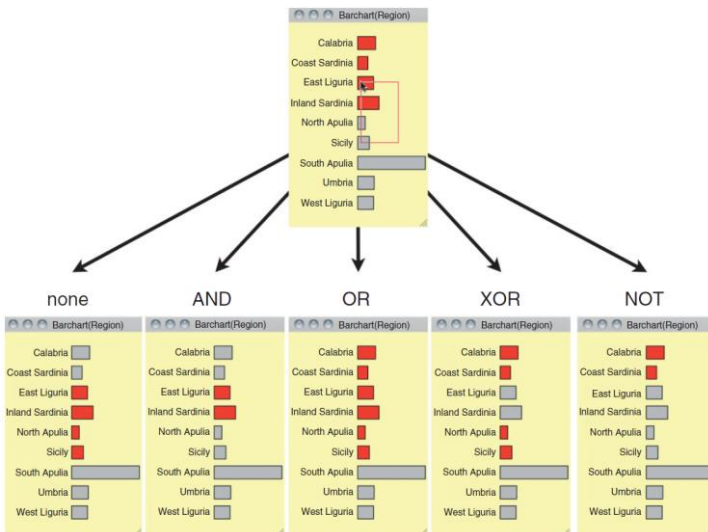


Selection: Lasso

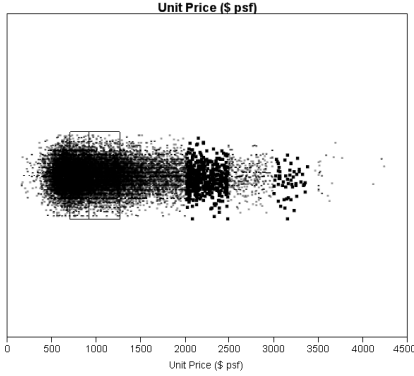
- Selecting a group of data points using JMP's Lasso tool 



Selection Modes



Selection with OR mode

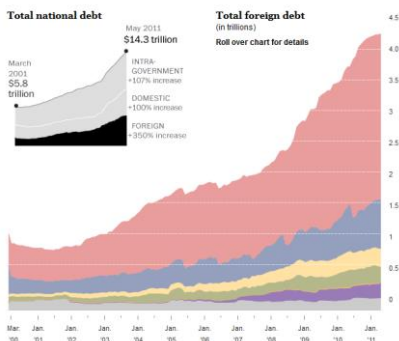


Explore

- Enable users to examine a different subset of data cases

Our mountain of debt

Foreign investors hold the largest share of privately held national debt. Estimated foreign holdings of U.S. Treasury securities have more than quadrupled since 2001. Some experts worry about the geopolitical consequences of foreign governments investing so deeply in U.S. Treasuries. But the investments also tie the fortunes of foreign governments more closely to those of the United States.



Source: <http://www.washingtonpost.com/wp-srv/special/business/foreign-held-us-debt/>

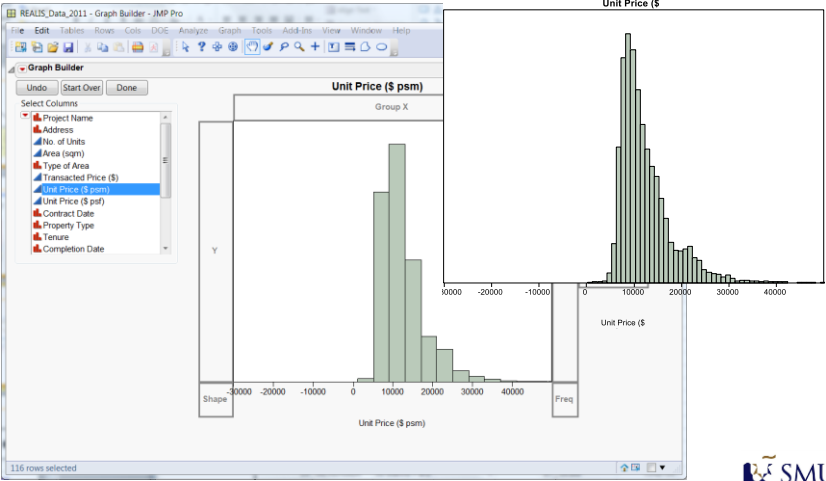
Explore

- Pan




Explore

- JMP's Grabber  is used to change the data bin dynamically

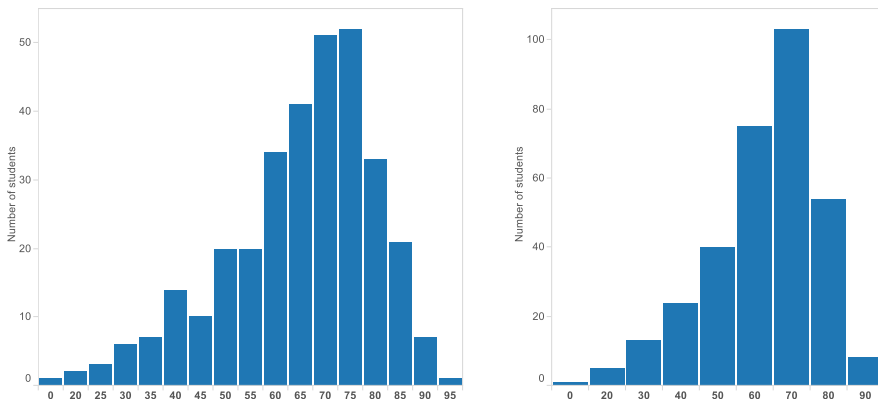


The screenshot shows the JMP Pro interface with a histogram of 'Unit Price (\$ psm)'. The 'Graph Builder' window is open, and the 'Grabber' tool is being used to adjust the bin width of the histogram. The histogram shows a distribution of unit prices with a peak around 10,000. The 'Unit Price (\$)' window is open, showing the current bin width and frequency.

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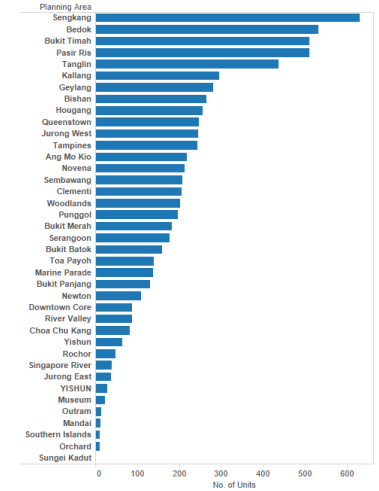
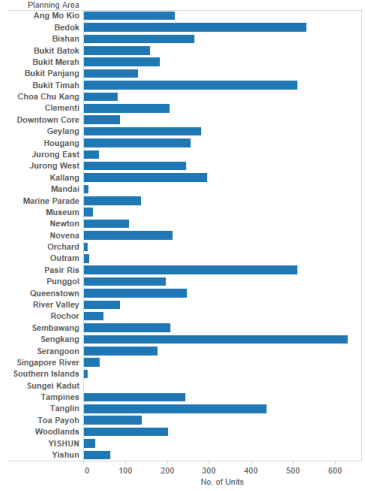
Explore

- Change the data bin dynamically



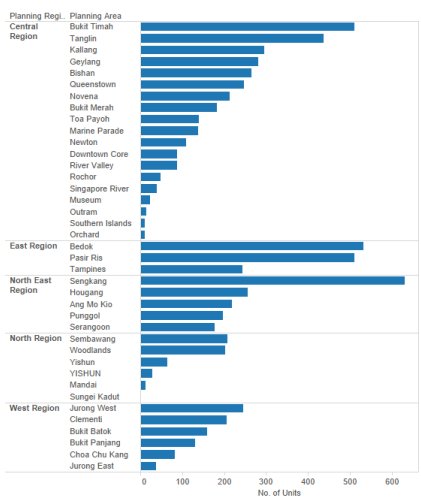
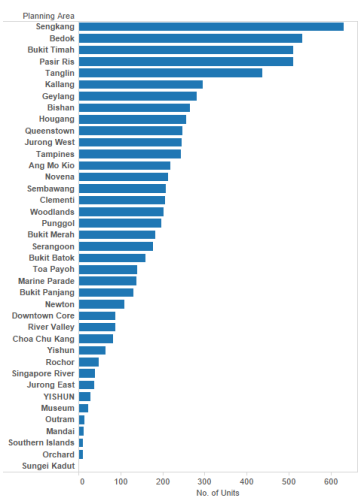
Reconfigure

- Sorting



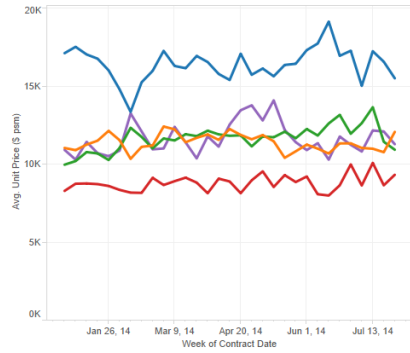
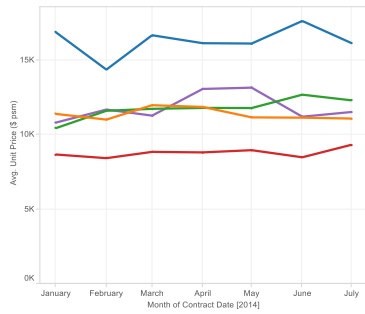
Reconfigure

- Adding variables



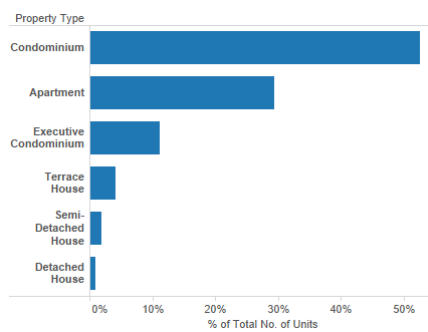
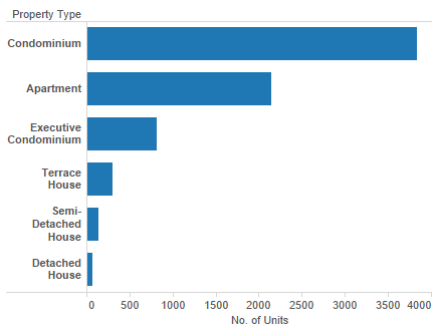
Reconfigure

- Aggregation



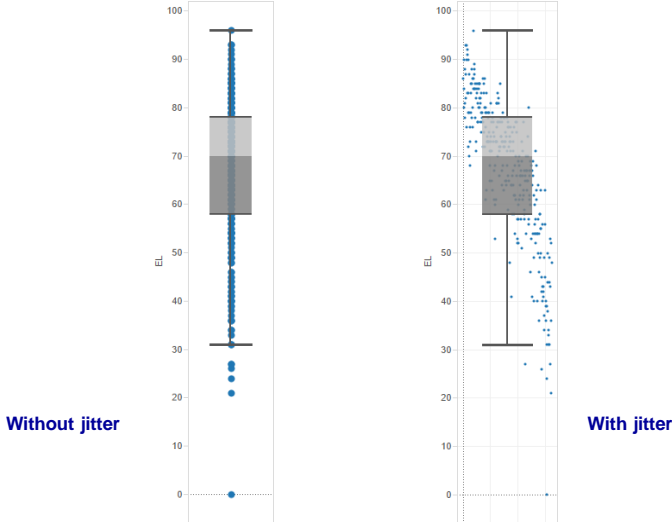
Reconfigure

- Re-expressing



Reconfigure

- Jittering

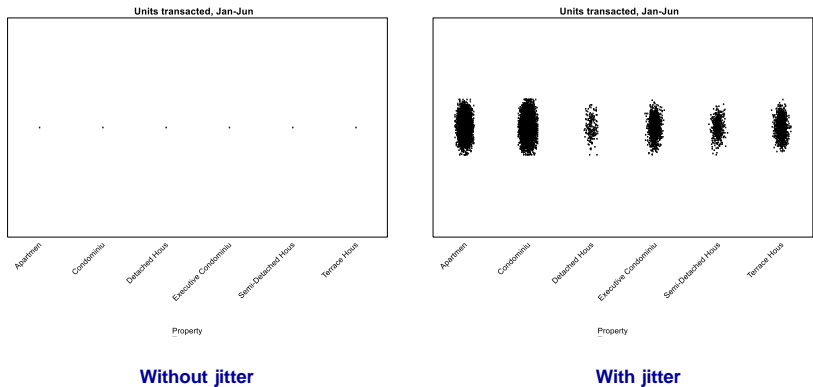


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Reconfigure

- Working with jitter

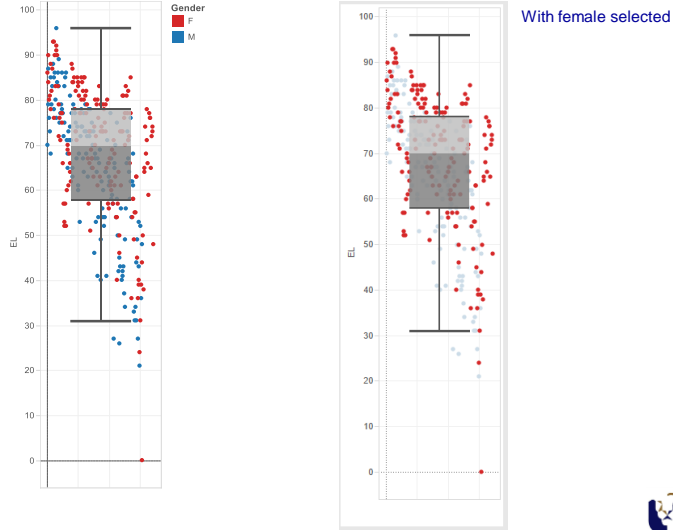


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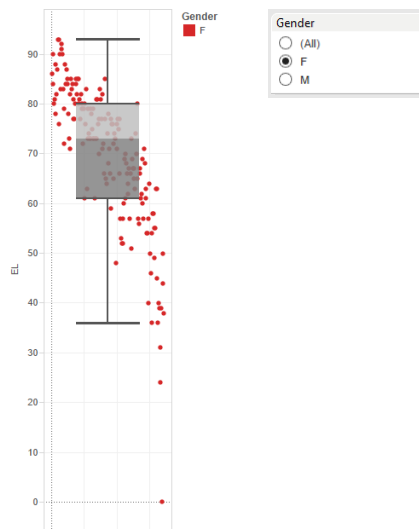
Highlighting

- Selected records are highlighted



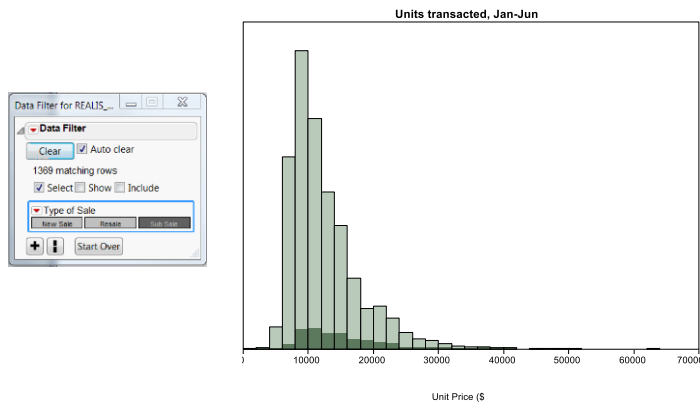
Filter

- Non-selected records are excluded in the graph



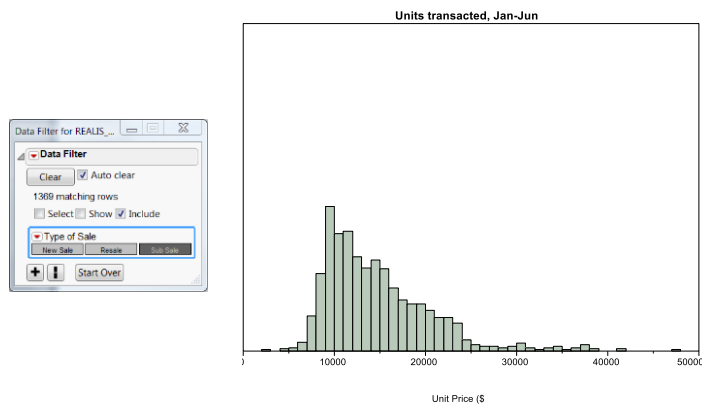
Filter

- In JMP's Data Filter, selected records are highlighted



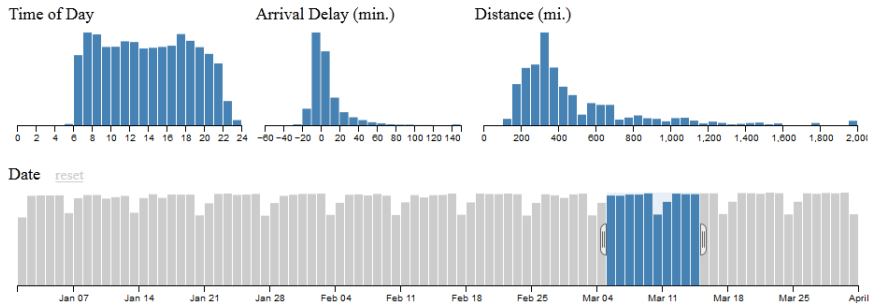
Filter

- Non-selected records are excluded in the graph



Filter

- <http://square.github.com/crossfilter/>



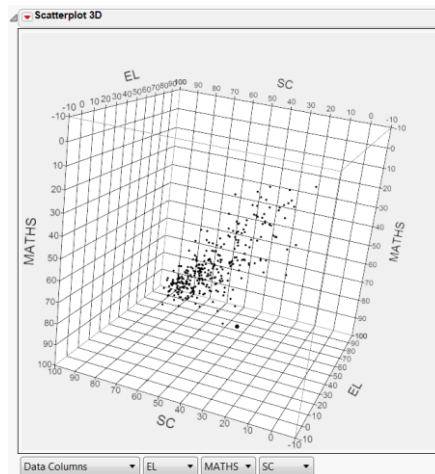
March 14, 2001

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.

26,093 of 231,083 flights selected.

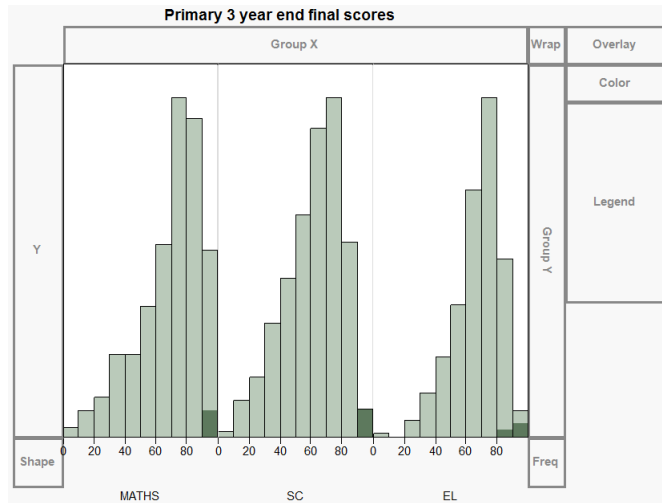
Rotating

- Touring view with JMP's 3D scatterplot



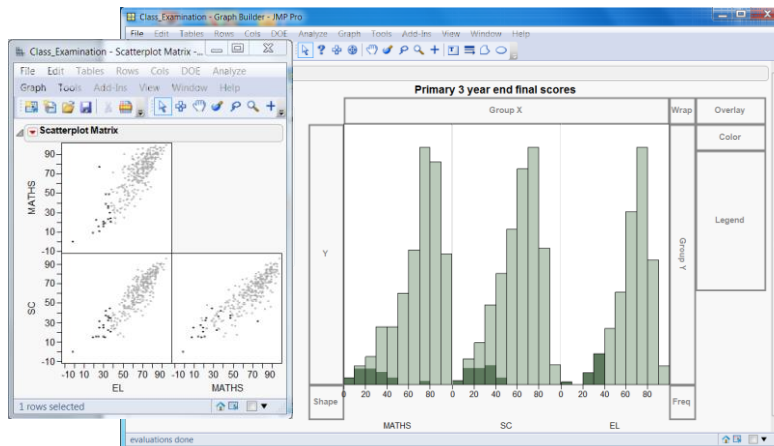
Connect: Coordinated Multiple Charts

- These bar graphs are linked.

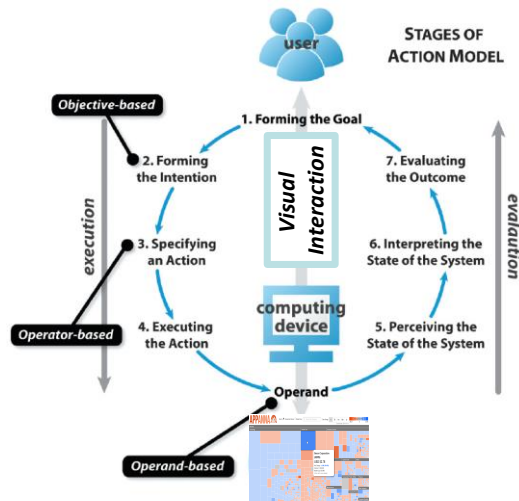


Connection: Linked Multiple Views

- The bar graphs and scatterplot matrix are linked



Interactive VA Design Model



Source: Roth, R.E. (2012) "Cartographic Interaction Primitive: Framework and Synthesis". *The Cartographic Journal*, Vol. 49, No. 4 pp. 376-395.

Visual Analytics Objective Primitives

objectives

visual insight

- | | | |
|--------------|---|--|
| 1. identify | → | e.g., ID, locate |
| 2. compare | → | e.g., difference, change |
| 3. rank | → | e.g., anomaly, outlier |
| 4. associate | → | e.g., correlation, trend, cause-effect |
| 5. delineate | → | e.g., cluster, hotspot, spike |

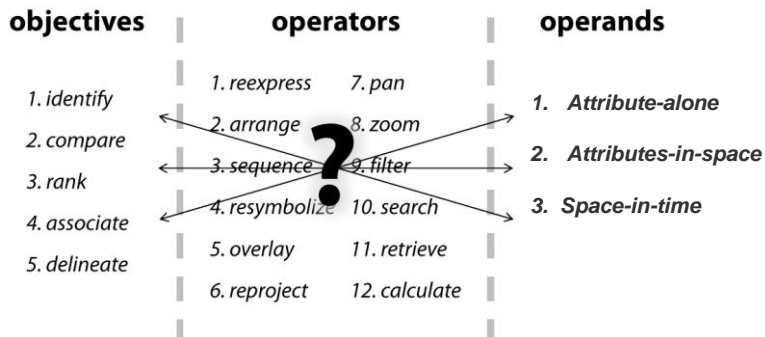
Interactive Analytics Operator Primitives

operators

- | | |
|-----------------------|----------------------|
| 1. <i>reexpress</i> | 7. <i>pan</i> |
| 2. <i>arrange</i> | 8. <i>zoom</i> |
| 3. <i>sequence</i> | 9. <i>filter</i> |
| 4. <i>resymbolize</i> | 10. <i>search</i> |
| 5. <i>overlay</i> | 11. <i>retrieve</i> |
| 6. <i>reproject</i> | 12. <i>calculate</i> |

Visual Analytics Design

- The syntactic of interaction primitives

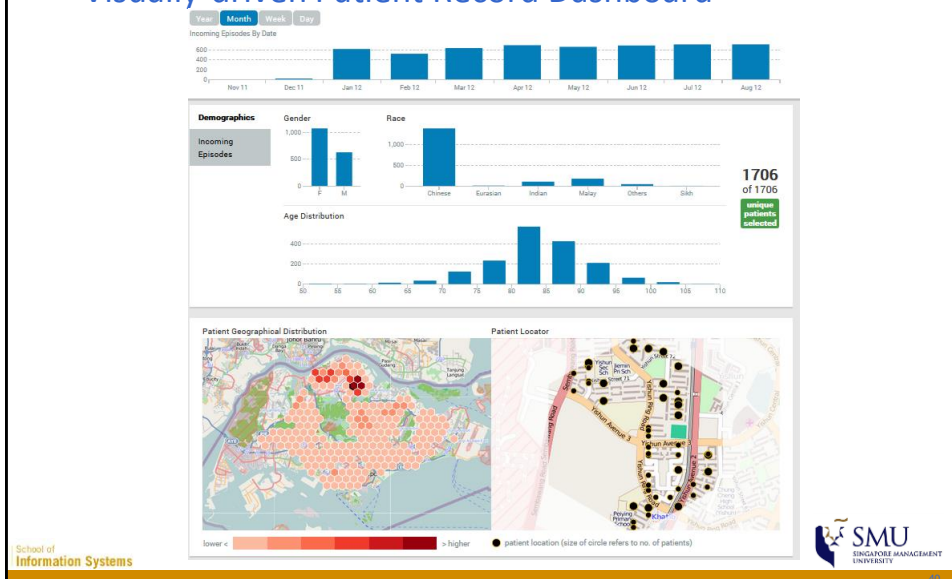


Interaction in action 1

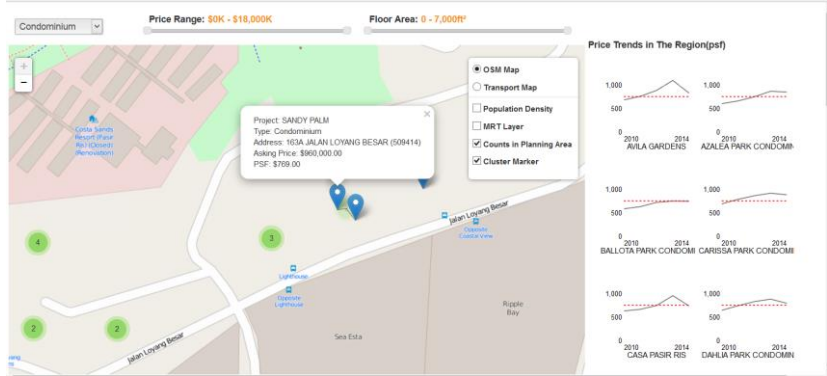


Interaction in action 2

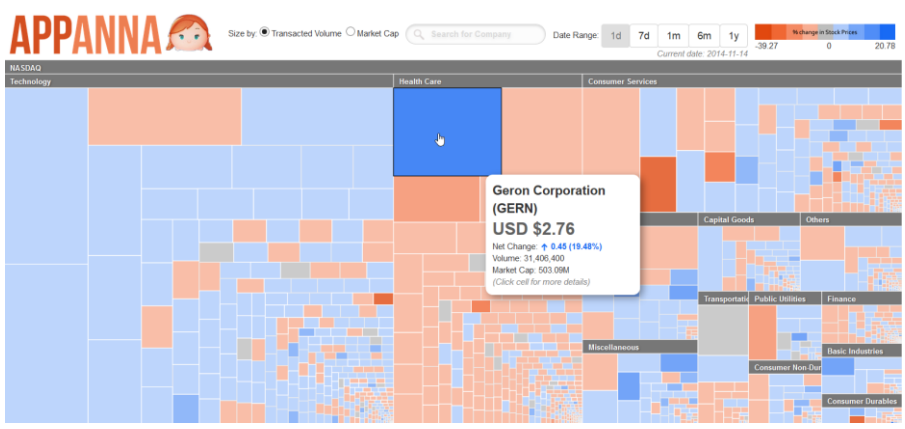
- Visually-driven Patient Record Dashboard



Interaction in action 3

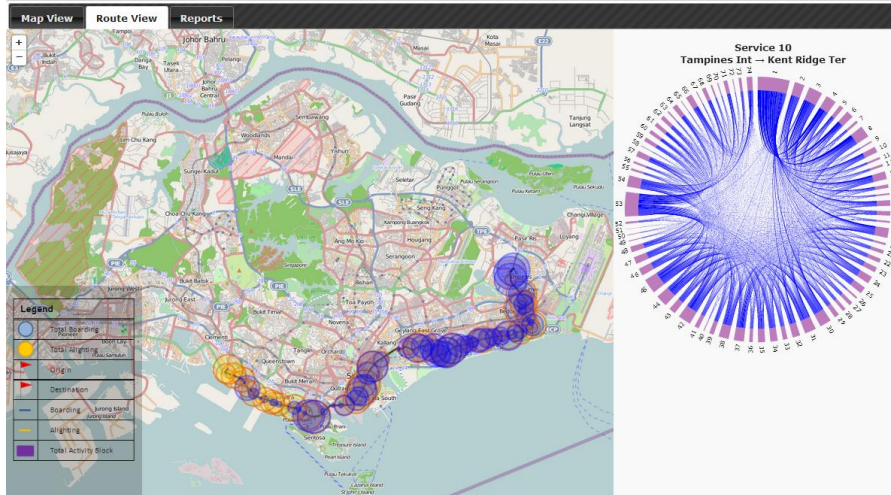


Interaction in action 4



Source: <http://napcrisis.me/is428/>

Interaction in action 5



Source: <http://10.0.106.64:8080/TPAS/>

Animation in Visual Analytics

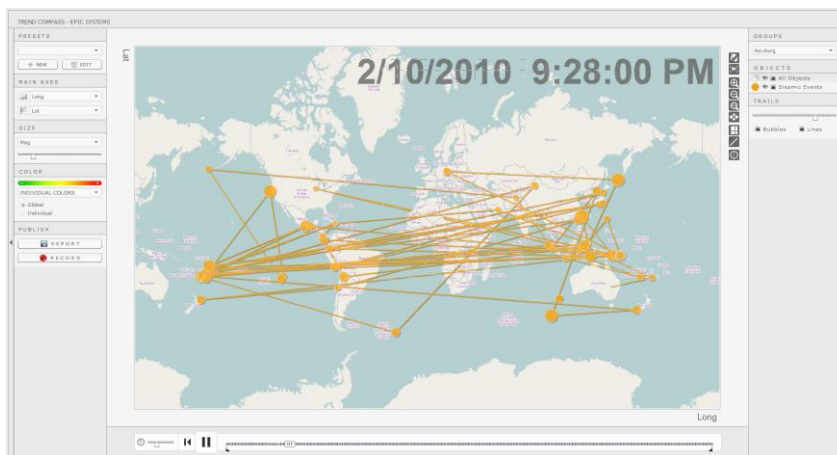
- To facilitating perception of changes when transitioning between related data graphics
- Do not confine to time-series data only

Animation for Visual Analytics

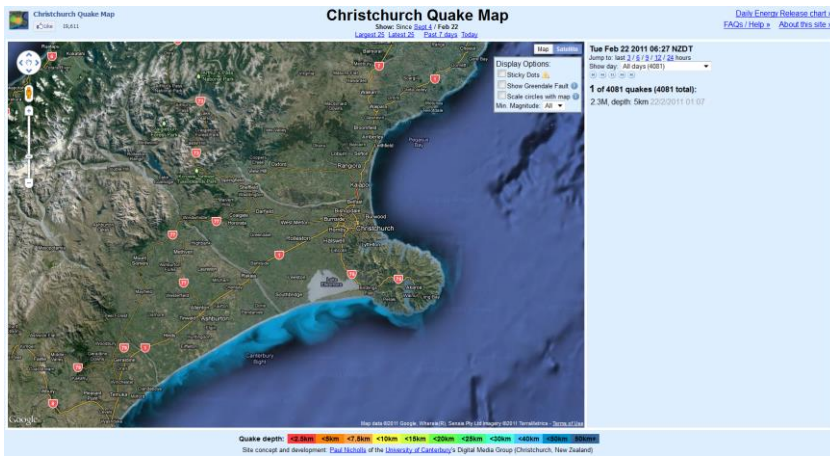
- Motion is highly effective at attracting attention
- Animation facilitates object constancy for changing objects
- Animated behaviours can give rise to perceptions of causality and intentionality, communicating cause-and-effect relationships and establishing narrative
- Animation can be emotionally engaging, engendering increased interest or enjoyment

There is also ChartJunk in Animated Data Graphics

- Very distracting and misleading!!!



A Better Used of Animation



Principles of Animation

- **Congruence principle** states that “the structure and content of the external representation should correspond to the desired and content of the internal representation.
- **Apprehension principle** states that “the structure and content of the external representation should be readily and accurately perceived and comprehended.

A Taxonomy of Transition Types

- View transformation
- Substrate transformation
- Filtering
- Ordering
- Timestep
- Visualisation change
- Data schema change

Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

Animation Design Considerations: Congruence

- Maintain valid data graphics during transitions
- Use consistent semantic-syntactic mappings
- Respect semantic correspondence
- Avoid ambiguity

Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

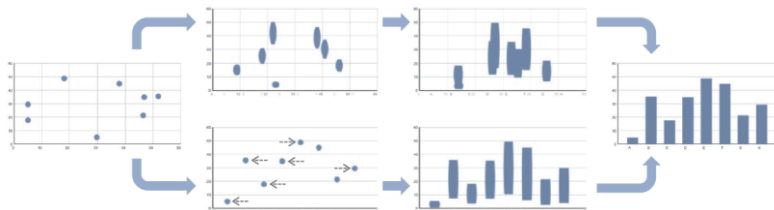
Animation Design Considerations: Apprehension

- Group similar transitions
- Minimise occlusion
- Maximise predictability
- Use simple transitions
- Use staging for complex transitions
- Make transitions as long as needed, but no longer

Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

Animating from a Scatter Plot to a Bar Chart

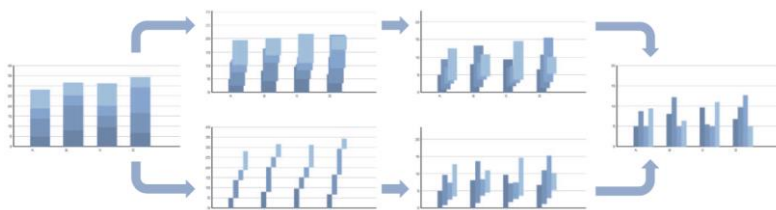
- The top path directly interpolates between the starting and ending states.
- The bottom path is staged: the first stage moves points to their x-coordinates and updates the x-axis, the second stage morphs the points into bars.



Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

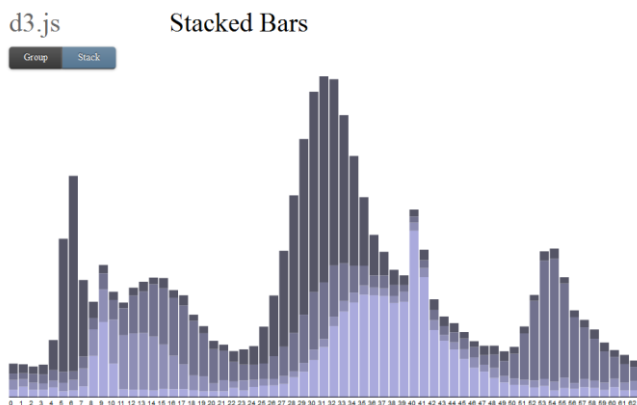
Animating from Stacked Bars to Group Bars

- 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 base line.



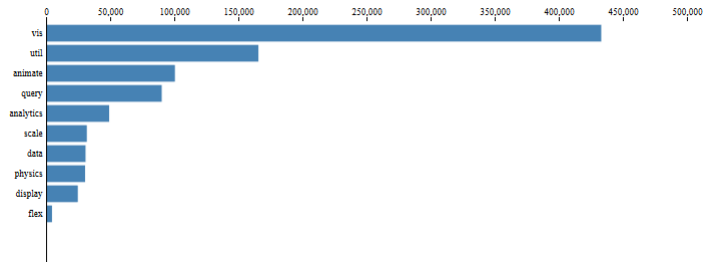
Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

A simple animated chart



Source: <http://mbostock.github.com/d3/ex/stack.html>

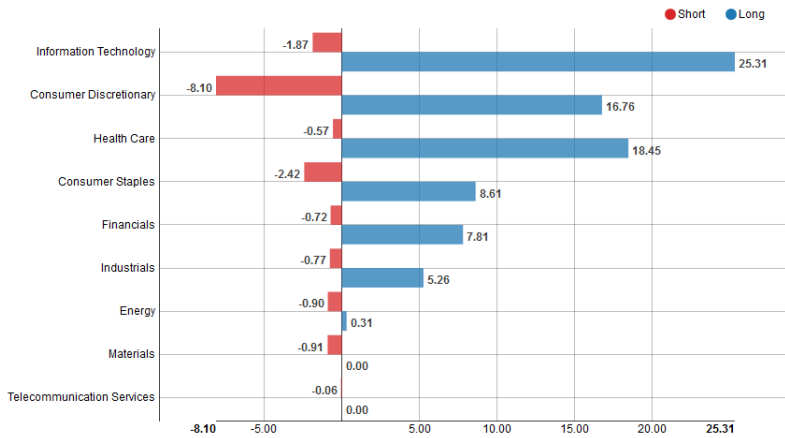
A hierarchical bar chart



Source: <http://mbostock.github.io/d3/talk/20111116/bar-hierarchy.html>

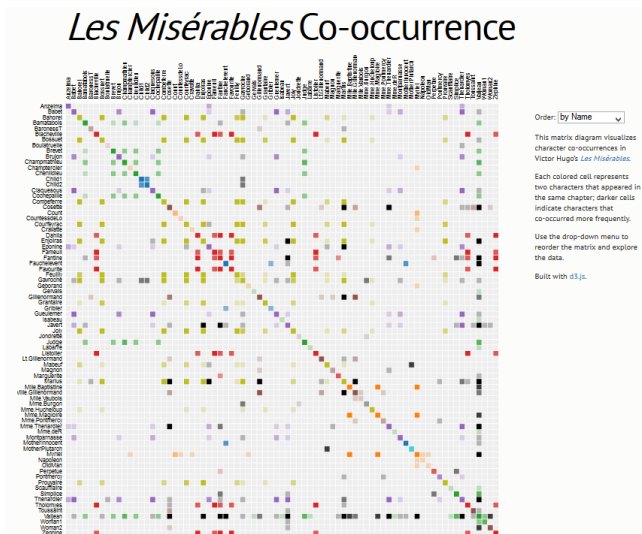
Animated bar chart

Horizontal Multi-Bar Chart



Source: <http://nvd3.com/ghpages/multiBarHorizontal.html>

Animated Co-occurrence matrix



Source: <http://bost.ocks.org/mike/miserables/>

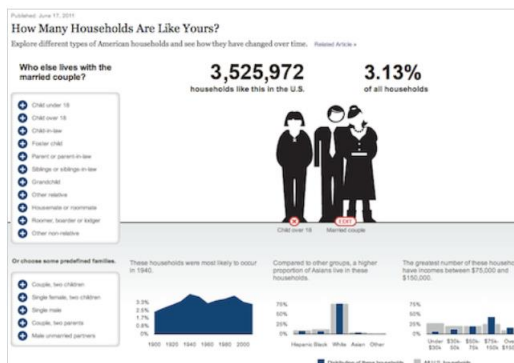
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An animated dashboard

The Original Design

The New York Times recently published an interactive graphic for exploring different types of American households. [Go check it out.](#)



Source: <http://worrydream.com/HowManyHouseholds/>

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A Multi-stage Animation of Changing values in a Donut Chart

- Stage 1: Wedges split into two rings
- Stage 2: Wedges translate to be centered on their final position
- Stage 3: Wedges then update their values, changing size
- Stage 4: Wedges reunite into a single ring



Source: Heer, J and Robertson G. (2007) Animated Transitions in Statistical data Graphics, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 13, No. 6, 1240-1247

Visual Analytics Tool evaluation

- http://202.161.43.23/IVAG/rice_yield.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v1_two_selector.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v3_one_selector.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v2_toggle_production.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v4_legend.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v2_toggle_yield.html

Visual Analytics Tool evaluation

- http://202.161.43.23/courseware_v4/Urban_dynamic/v2_play_button.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v2_toggle_production.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v2_toggle_yield.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v3_one_selector.html
- http://202.161.43.23/courseware_v4/multi_line_chart/v4_legend.html