



# Interactivity



# INTRODUCTION

# Data Analysis

“Data analysis, like experimentation, must be considered as an open-ended, **highly interactive, iterative process**, whose actual steps are selected segments of a stubby branching, tree-like pattern of possible actions.”

The Collected Works of John W. Tukey, Volume IV Philosophy and Principles of Data Analysis: 1965-1986, by John W. Tukey, and David R. Cox

# Types of Navigation

- Exploratory Navigation
- Directed Navigation

# Types of Navigation

- **Exploratory Navigation**
  - Explore data
  - Find something interesting
  - Ask a question...
- **Directed Navigation**
  - Have a specific question
  - Search for an answer
  - Produce an answer

# Discussion

Which type of navigation (**exploratory** vs **directed**) is information visualization well-suited for?

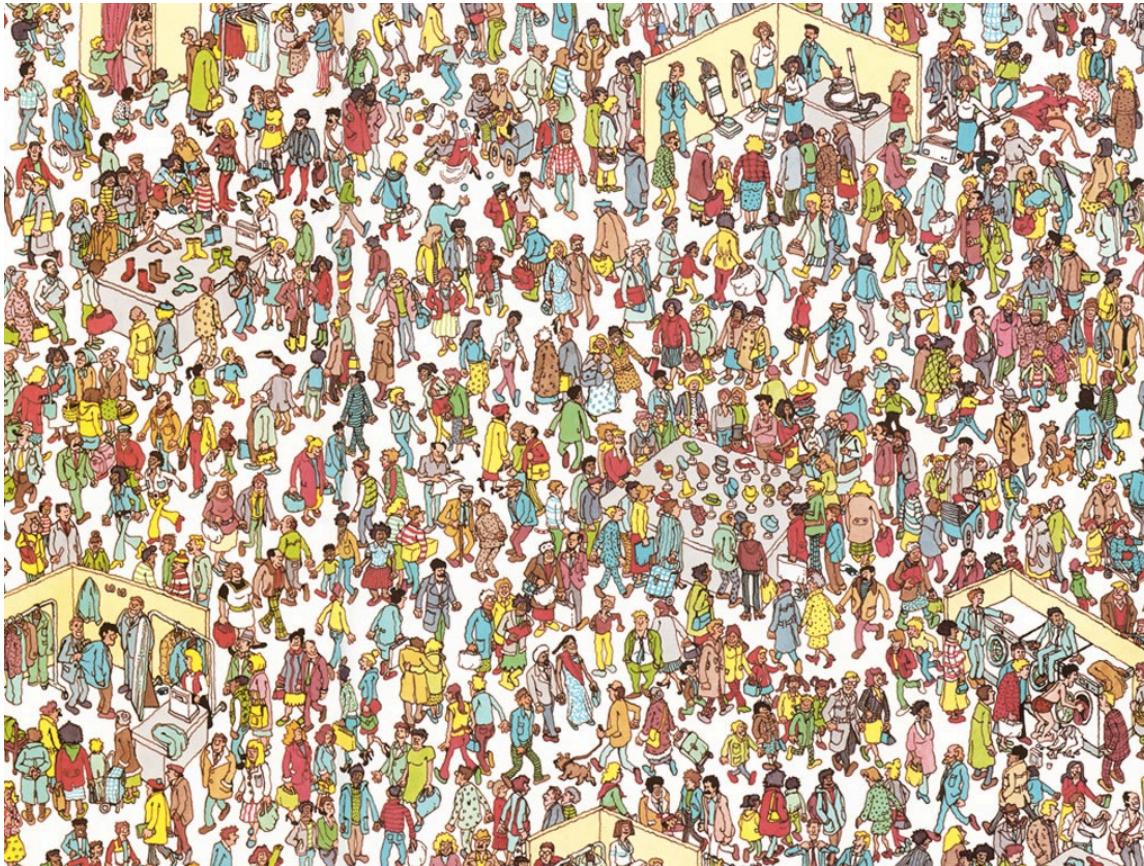
# Observation and Spy Craft

- **Broad Awareness**
  - Overview
  - Awareness of abnormalities
- **Close Observation and Analysis**
  - Shift focus on abnormality
  - Analyze abnormality

# Shneiderman's Mantra



Readings in Information Visualization: Using Vision to Think  
by Stuart K. Card, Jock D. Mackinlay, and Ben Shneiderman, Academic Press, San Diego, California, 1999, p625



<http://findwally.co.uk/fankit/graphics/IntlManOfLiterature/Scenes/DepartmentStore.jpg>

# Shneiderman's Mantra

- **Overview**
  - Reduces search time
  - Allows detection of overall patterns
  - Allows user to choose next move
- **Zoom and Filter**
  - Iteratively narrow focus
  - Remove extraneous information
- **Details On-Demand**
  - Drill down to details

# Types of Representations

- **Static Representations**
  - No Interactivity
- **Manipulable Representations**
  - Manipulate view of data
  - Actions include zoom, pan, rotate, etc.
- **Transformable Representations**
  - Manipulate input data
  - Actions include filter, average, etc.

# Manipulable Representations

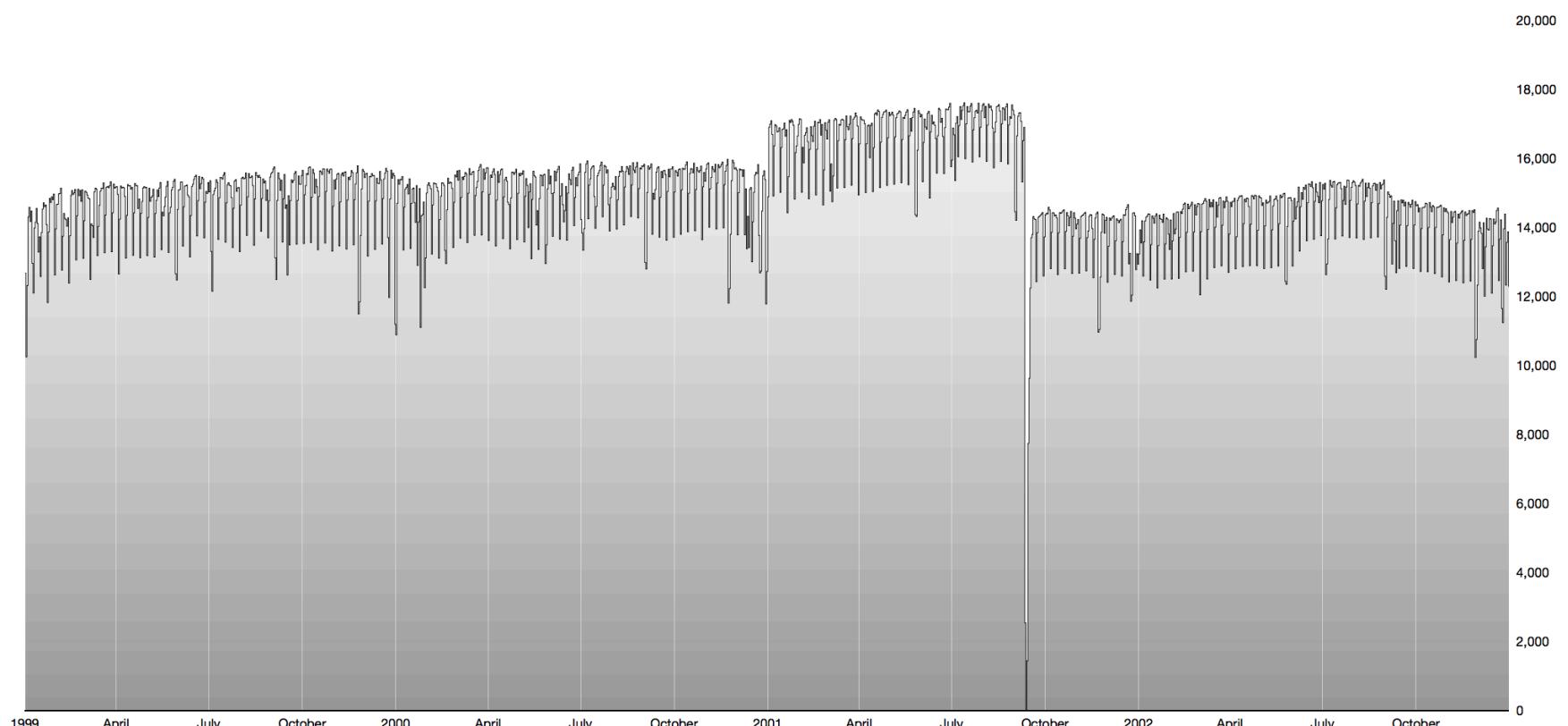
- **Exploration**
  - Zooming, rotation, scrolling/panning, sorting
- **Overview + Details**
  - Two separate views
- **Focus + Context**
  - One integrated view without occlusion
  - Focus shown in greater detail
  - Context shown in reduced detail

# EXPLORATION

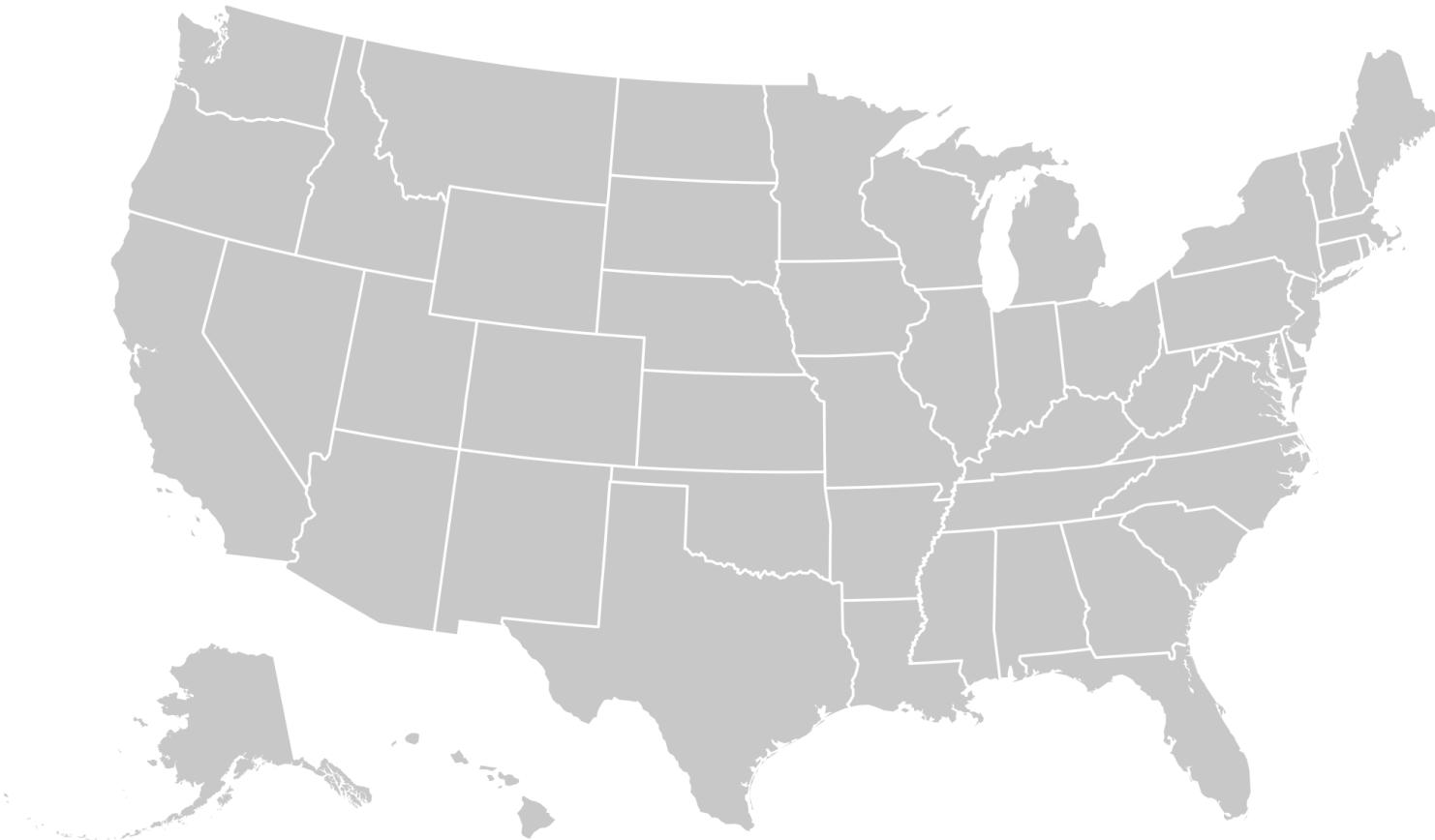
## Manipulable Representations

# Exploration

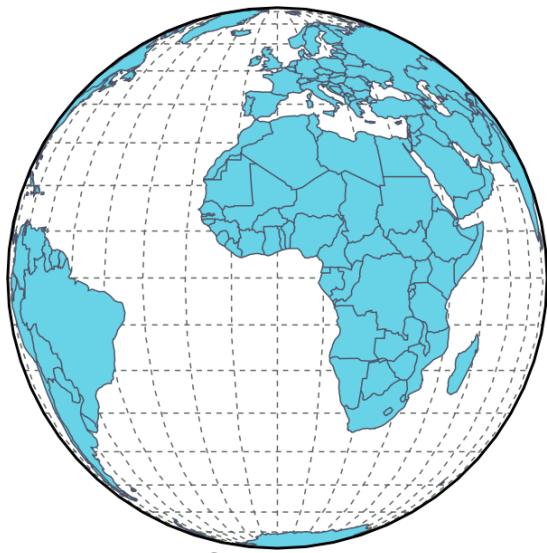
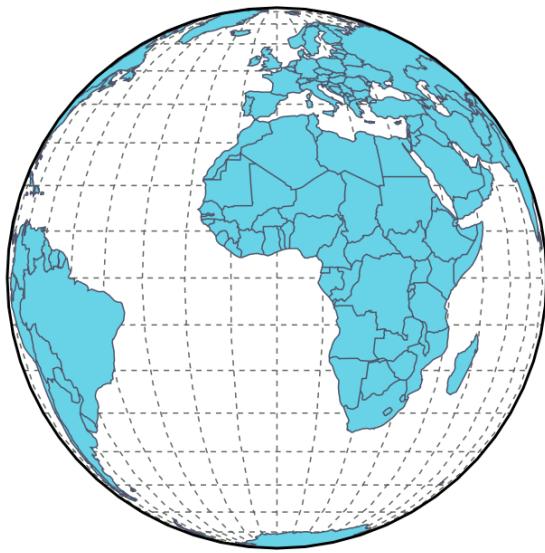
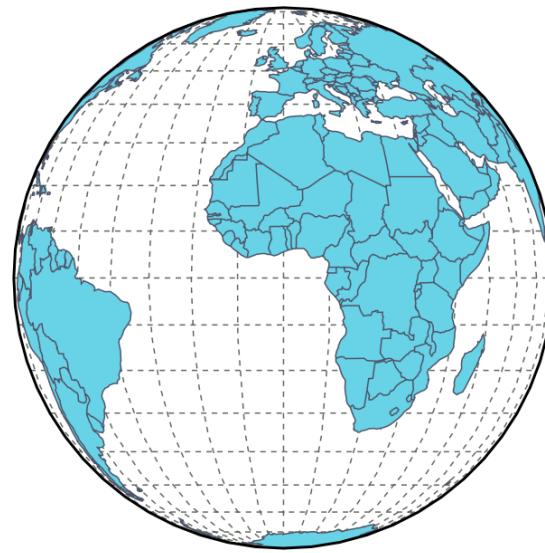
- **Operations**
  - Zooming, panning or scrolling, rotating, and more
- **Considerations**
  - Avoid blinking (change blindness)
  - Keep transitions smooth to maintain context



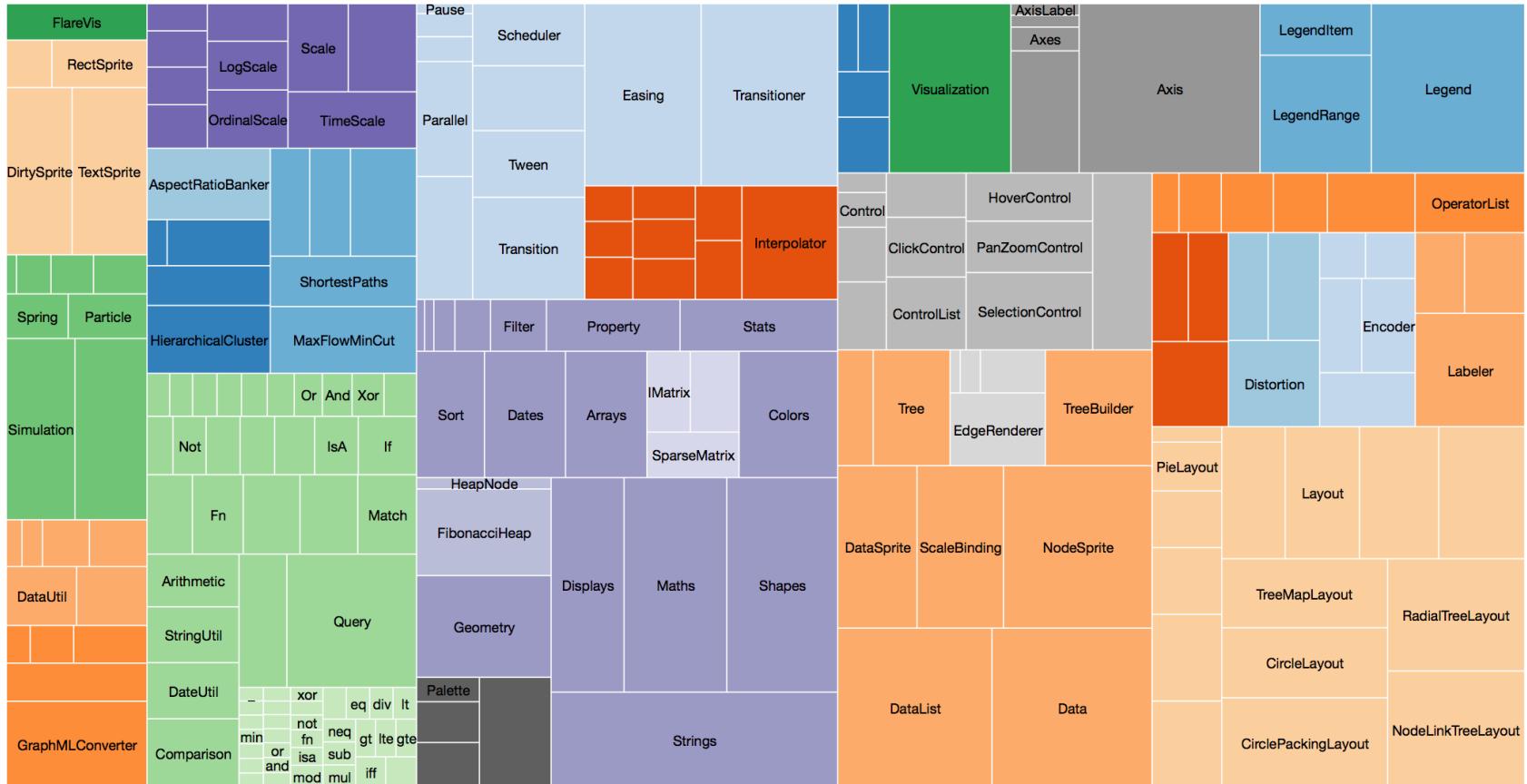
<http://mbostock.github.io/d3/talk/20111018/area-gradient.html>



<http://bl.ocks.org/mbostock/9656675>

 $\lambda=0^\circ$  $\varphi=0^\circ$  $\gamma=0^\circ$ 

<https://www.jasondavies.com/maps/rotate/>



<http://mbostock.github.io/d3/talk/20111018/treemap.html>

# OVERVIEW + DETAIL

## Manipulable Representations

# Overview + Detail

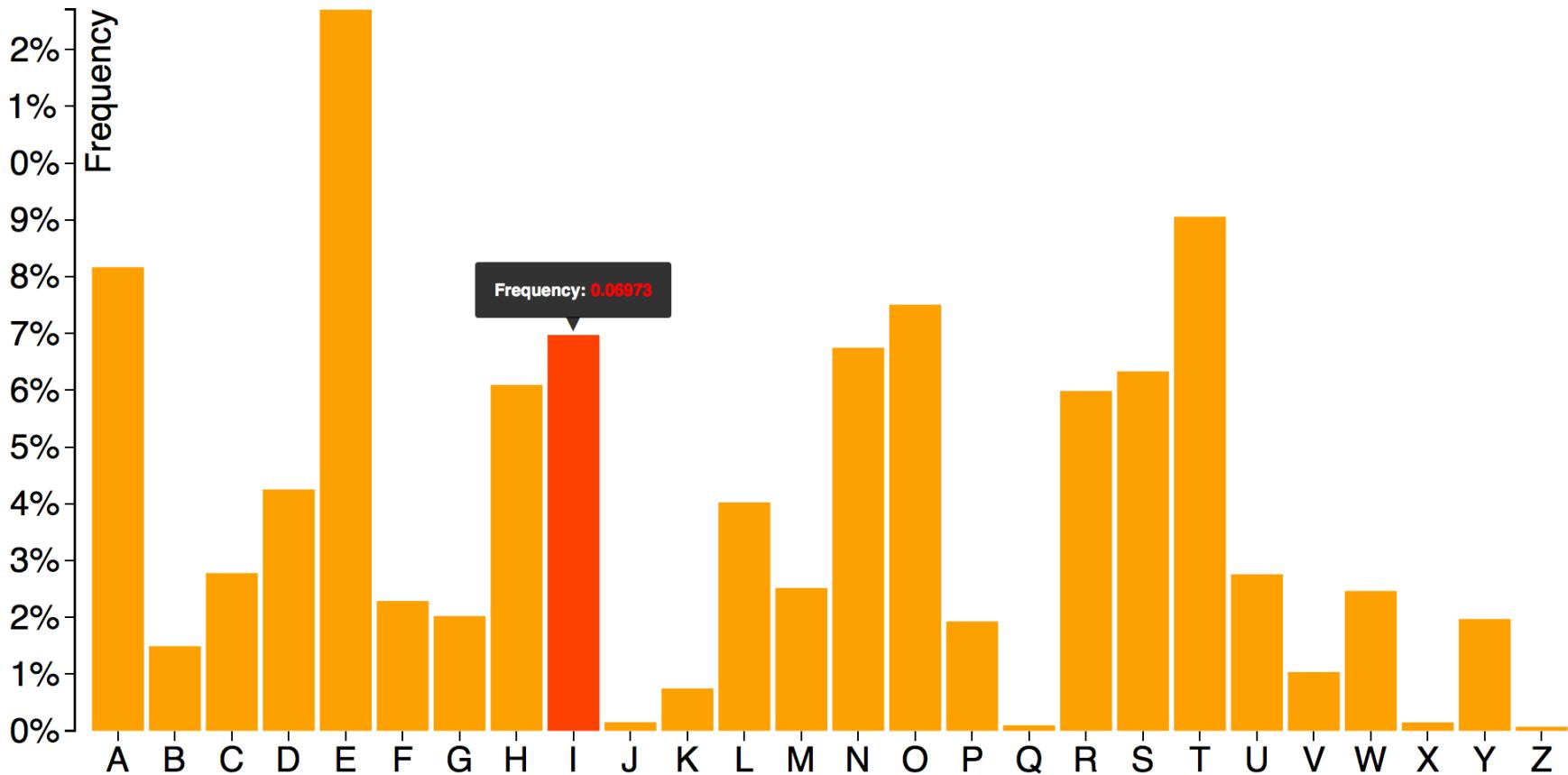
- **Overview View**

- Use for navigation or search tasks
- Avoid cluttering overview with too much detail

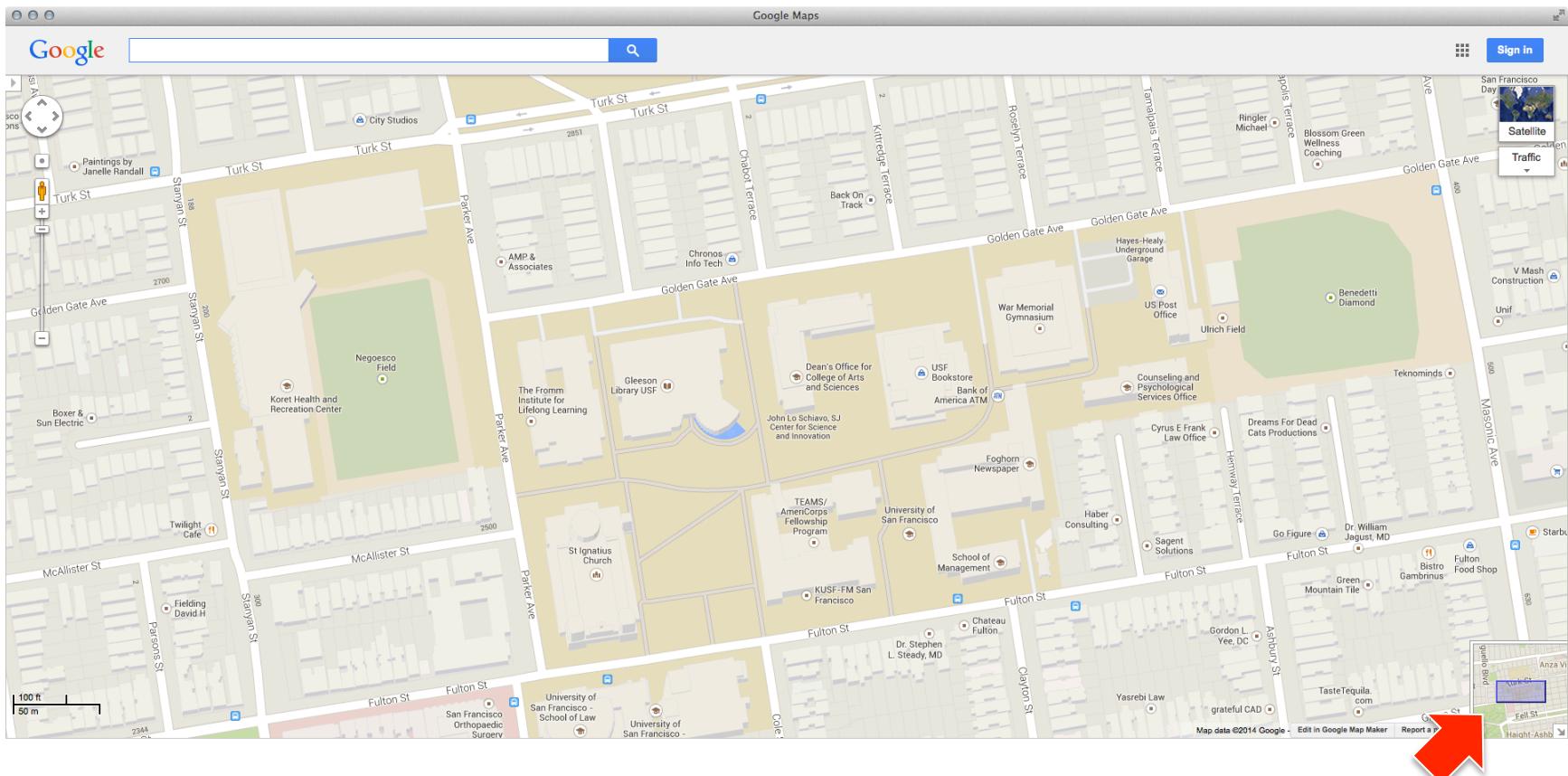
- **Detail View**

- Shows additional information
- Data selected from overview

<http://www.infovis-wiki.net/index.php?title=Overview-plus-Detail>



<http://bl.ocks.org/Caged/6476579>



<https://www.google.com/maps?t=m&ll=37.777635,-122.445502&z=16&output=classic&dg=opt>

Interactivity.pptx

Search in Presentation

Home Themes Tables Charts SmartArt Transitions Animations Slide Show Review

Slides Layout Font Paragraph Insert Format Slide Show

New Slide Section Slides Outline

15 20

# Overview + Detail

- Overview View
  - Use for navigation or search tasks
  - Avoid cluttering overview with too much detail
- Detail View
  - Shows additional information
  - Data selected from overview

<http://www.infovis-wiki.net/index.php?title=Overview-plus-Detail>

Interactivity Last Updated March 30, 2014

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Click to add notes

Slide 20 of 56 216%

Microsoft Powerpoint

```
IndexTest.java
public class IndexTest {
    @Test
    public void testNoOutput() throws IOException {
        String base = ProjectTest.getBaseDirectory();
        Path input = Paths.get(base, "input", "index", "simple");
        Path output = Paths.get("index.txt");

        String[] args = {
            "-d", input.toAbsolutePath().normalize().toString(),
            "-i", output.toAbsolutePath().normalize().toString()
        };

        Files.deleteIfExists(output);
        ProjectTest.checkExceptions("No Output", args);

        String errorMessage = String.format(
            "%n" + "Test Case: %s%n" + "%s%n",
            "No Output",
            "Do not create index.txt unless proper flag prov
        );

        assertFalse(errorMessage, Files.isReadable(output));
    }

    public static class IndexOutputTest {
        @Test
        public void testIndexSimple() {
            String base = ProjectTest.getBaseDirectory();
            String name = "index-simple.txt";

            Path input = Paths.get(base, "input", "index", "simple");
            Path output = Paths.get(base, "output", name);
            Path result = Paths.get("result", name);

            String[] args = new String[] {
                "-d", input.toAbsolutePath().normalize().toString(),
                "-i", result.toAbsolutePath().normalize().toString()
            };
        }
    }
}

SearchTest.java
public class SearchTest {
    @Test
    public void testNoWriteDirectory() {
        String base = ProjectTest.getBaseDirectory();
        Path input = Paths.get(base, "input", "index", "simple");
        Path query = Paths.get(base, "input", "queries", "simpl

        try {
            Path path = Files.createTempDirectory(Paths.get(".").toFile().deleteOnExit());

            String[] args = new String[] {
                "-d", input.toAbsolutePath().toString(),
                "-q", query.toAbsolutePath().toString(),
                "-r", path.toAbsolutePath().toString()
            };

            Driver.main(args);
        } catch (Exception e) {
            StringWriter writer = new StringWriter();
            e.printStackTrace(new PrintWriter(writer));

            fail(String.format(
                "%n" + "Test Case: %s%n" + "Exception: %s%n",
                "No Write Directory", writer.toString()));
        }
    }

    public static class SearchOutputTest {
        @Test
        public void testSearchSimple() {
    }
}
```

Sublime Text 2 • <http://www.sublimetext.com/>

# FOCUS + CONTEXT

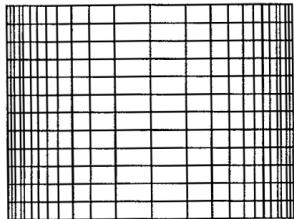
## Manipulable Representations

# Focus + Context

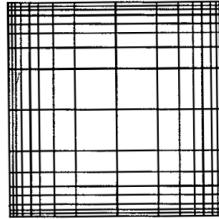
- **Fisheye Distortion**
  - Center of distortion provides **focus**, surrounding area provides **context**
- **Brushing**
  - Highlighted (brushed) data provides **focus**, greyed-out data provides **context**
- **Linked Views**
  - Highlighted data provides **focus**, multiple linked views provides **context**

<http://www.infovis-wiki.net/index.php/Focus-plus-Context>

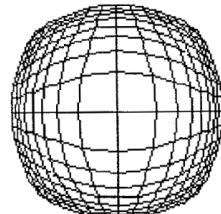
# Fisheye Distortion



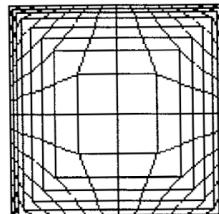
(c)



(d)



(e)

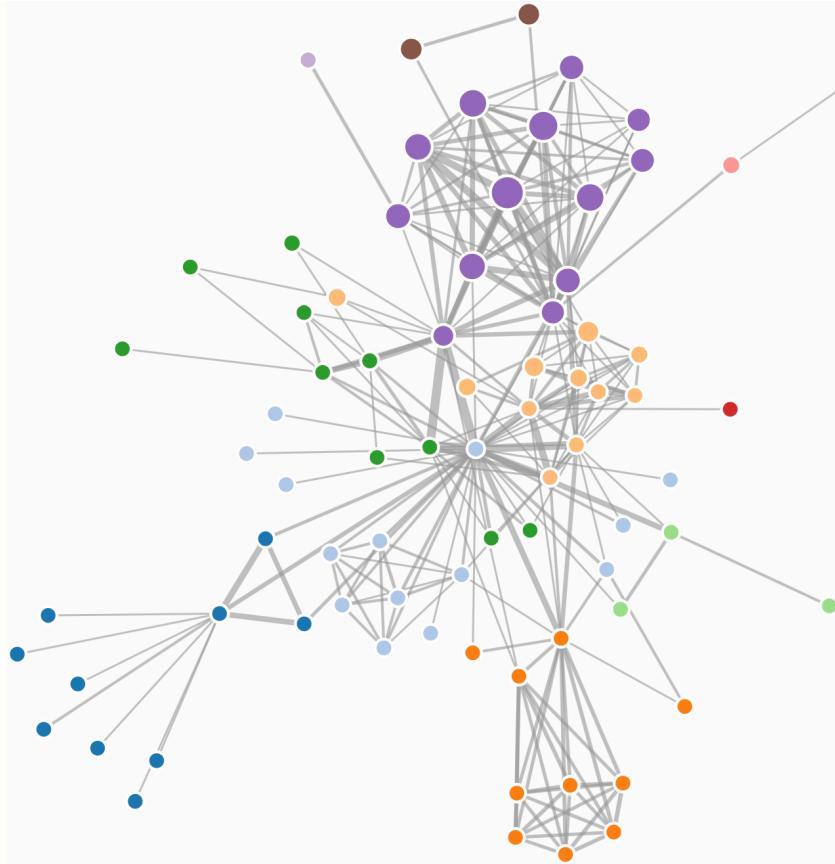


(f)

Fig. 11. The Fisheye View: (a) a typical transformation function; (b) the corresponding magnification function; (c) the application of the Fisheye View in one dimension; (d) a Cartesian Fisheye View in two dimensions; (e) a polar Fisheye View; (f) a normalized polar Fisheye View.

“A Review and Taxonomy of Distortion-Oriented Presentation Techniques” by Y. K. Leung and M. D. Apperley



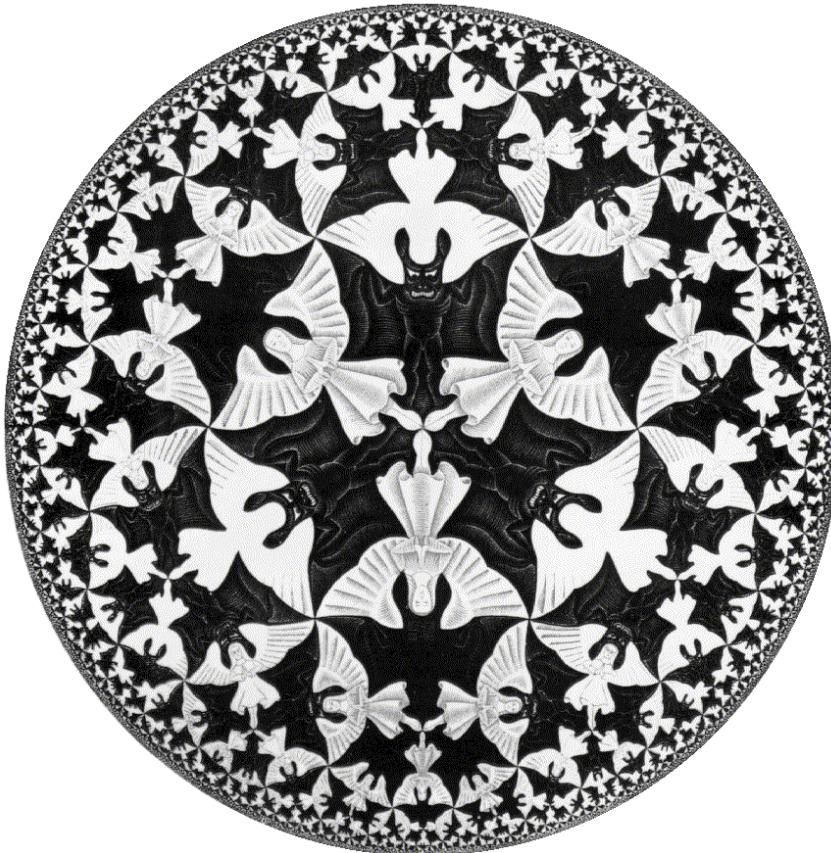
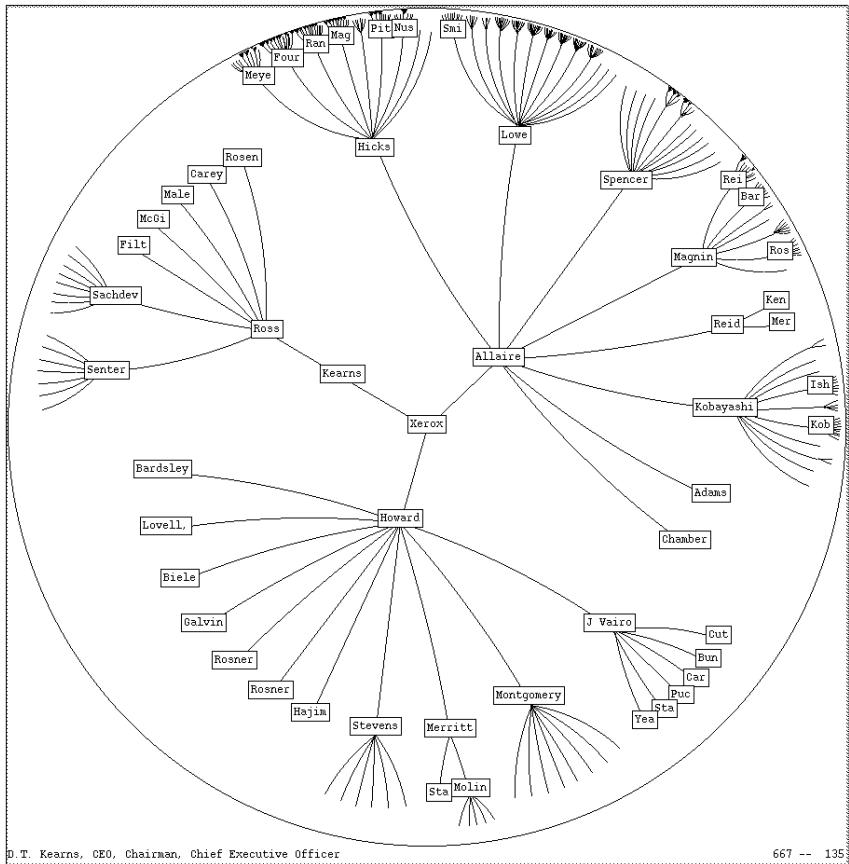


<http://bost.ocks.org/mike/fisheye/>

# Hyperbolic Trees

- Components diminish in size as move outwards
  - Uses fisheye distortion
- Focus changed by clicking a node
  - Node moves to center and increases in size
  - Other nodes move to edges and decrease in size
- Allows display of large hierarchical trees without loss of focus and context

[http://www.sigchi.org/chi95/Electronic/documents/papers/jl\\_bdy.htm](http://www.sigchi.org/chi95/Electronic/documents/papers/jl_bdy.htm)



[http://www.sigchi.org/chi95/Electronic/documents/papers/jl\\_bdy.htm](http://www.sigchi.org/chi95/Electronic/documents/papers/jl_bdy.htm)

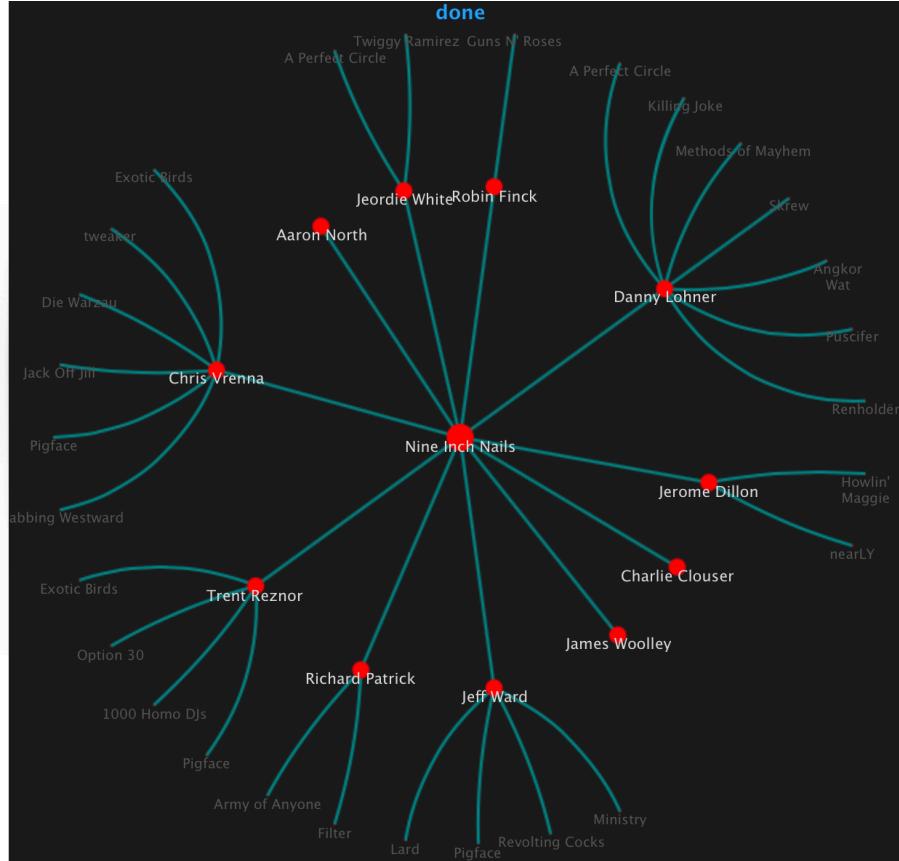
## Tree Animation

A static JSON Tree structure is used as input for this animation.

Clicking on a node should move the tree and center that node.

The centered node's children are displayed in a relations list in the right column.

## See the Example Code



## Nine Inch Nails

## Connections:

- Jerome Dillon  
(relation: member of band)
  - Charlie Clouser  
(relation: member of band)
  - James Woolley  
(relation: member of band)
  - Jeff Ward  
(relation: member of band)
  - Richard Patrick  
(relation: member of band)
  - Trent Reznor  
(relation: member of band)
  - Chris Vrenna  
(relation: member of band)
  - Aaron North  
(relation: member of band)
  - Jeordie White  
(relation: member of band)
  - Robin Fink  
(relation: member of band)
  - Danny Lohner  
(relation: member of band)

<http://philogb.github.io/jit/static/v20/Jit/Examples/Hypertree/example1.html>

# Brushing and Linked Views

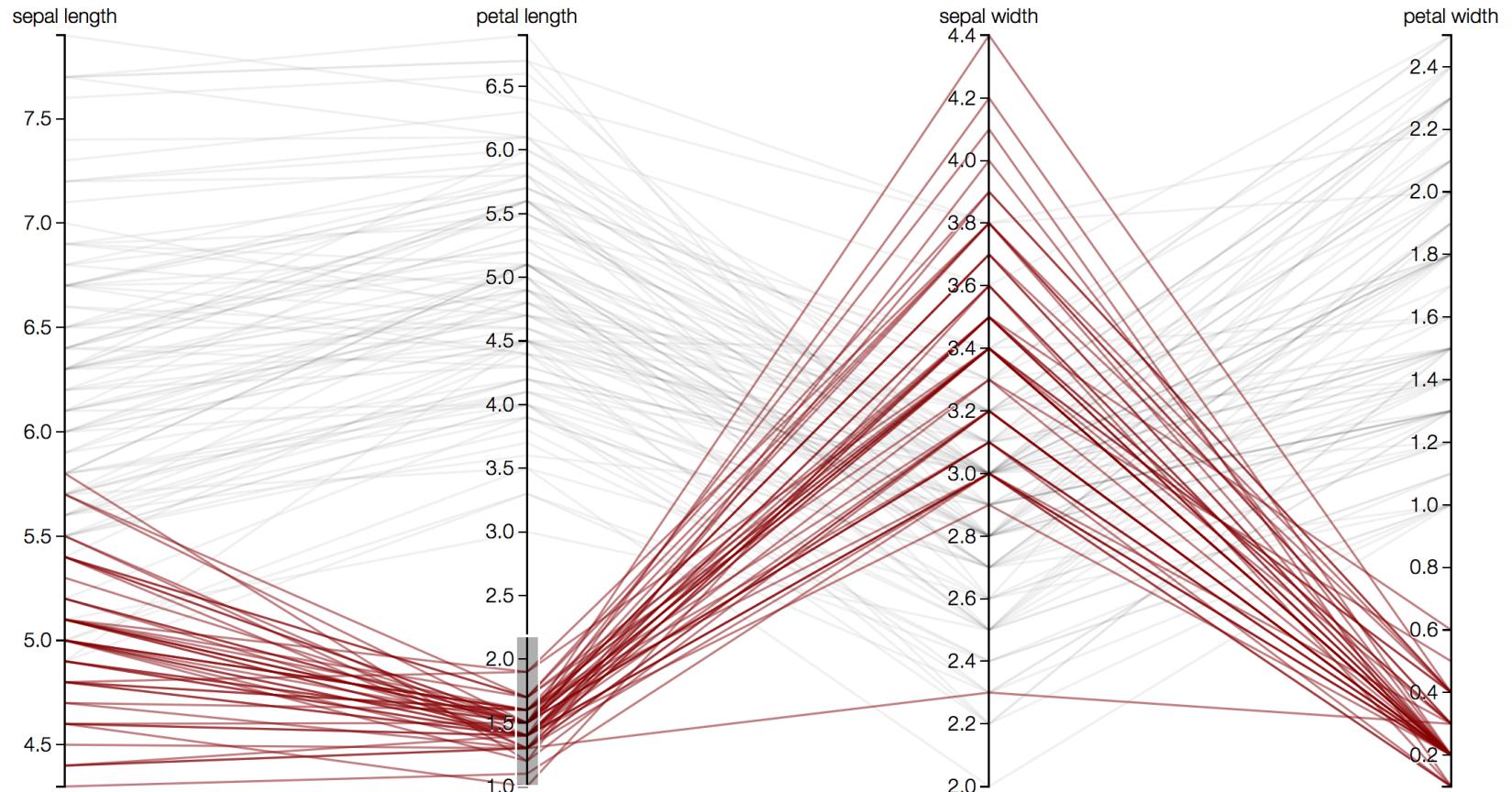
- **Brushing**

- Emphasize specific data points (bring to foreground)
- De-emphasize other data points (bring to background)

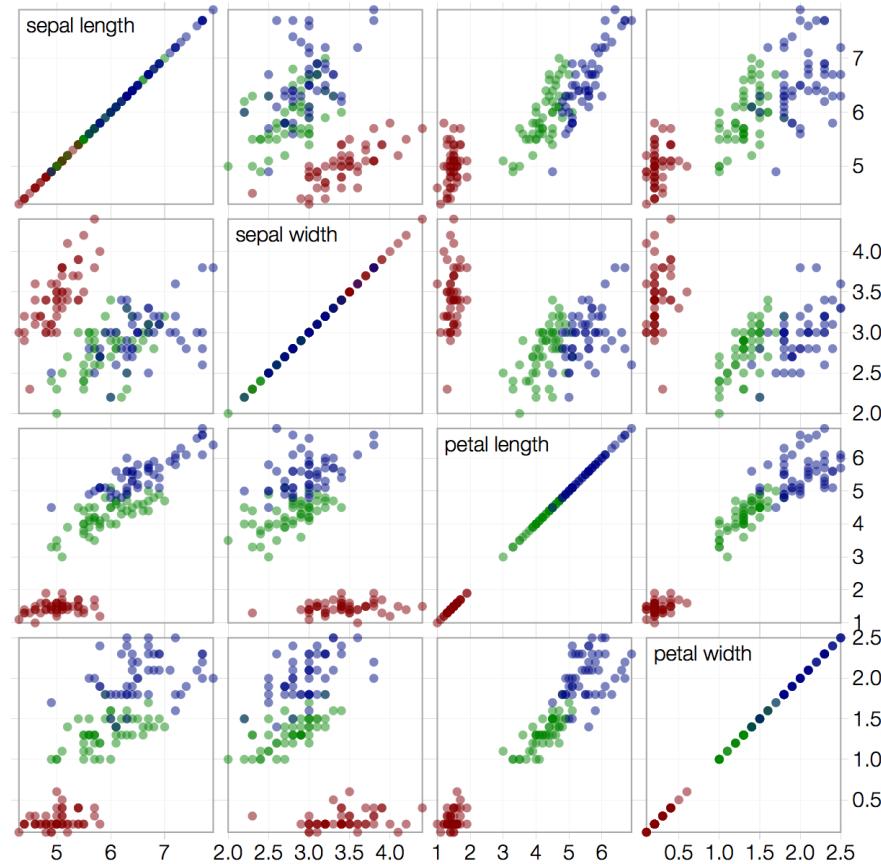
- **Linked Views**

- Often combined with brushing
- Show highlighted data across multiple different views of the data for more context

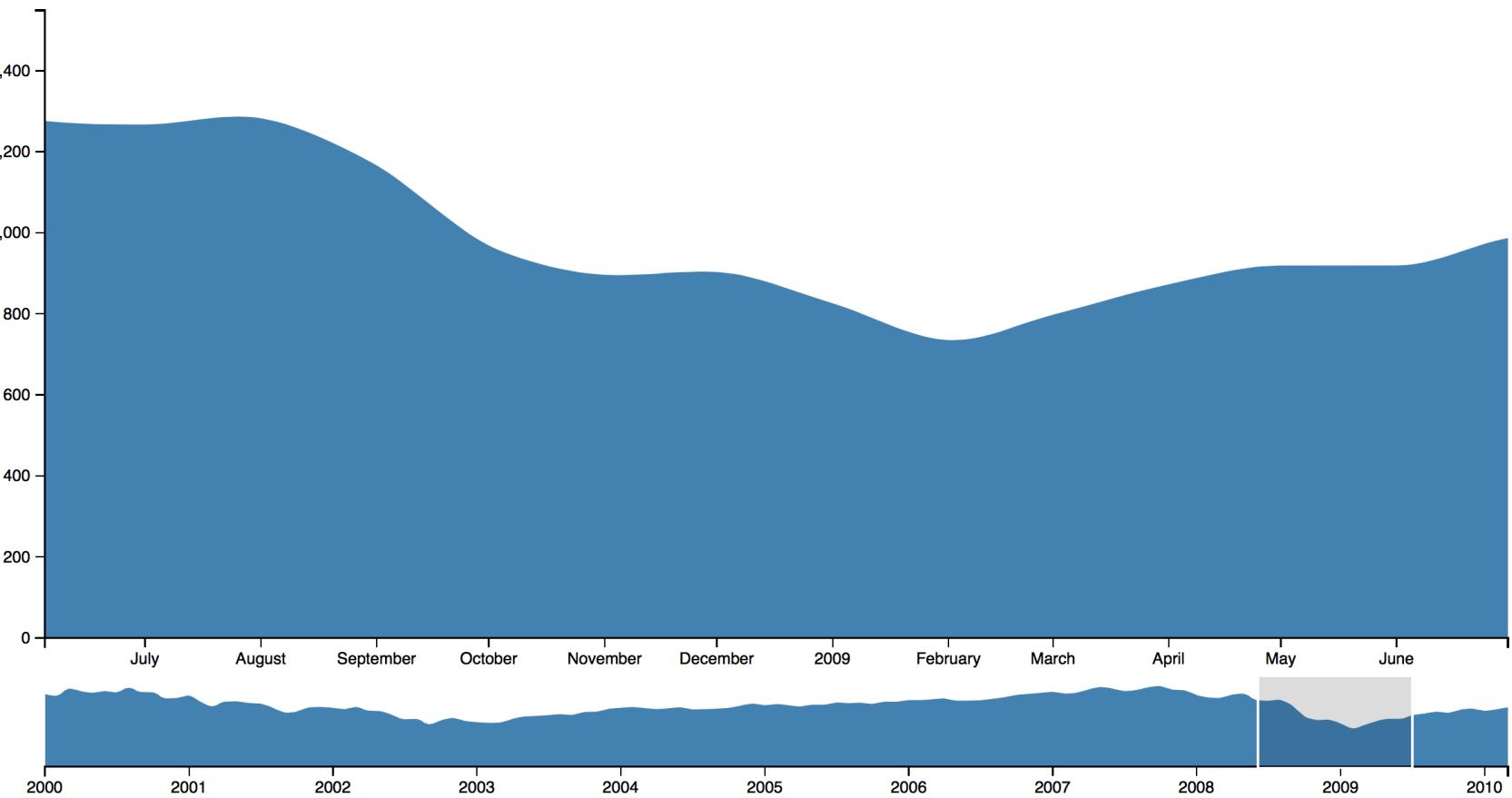
[http://www.infovis-wiki.net/index.php?title=Linking\\_and\\_Brushing](http://www.infovis-wiki.net/index.php?title=Linking_and_Brushing)



<http://mbostock.github.com/d3/talk/20111116/iris-parallel.html>



<http://mbostock.github.io/d3/talk/20111116/iris-splom.html>



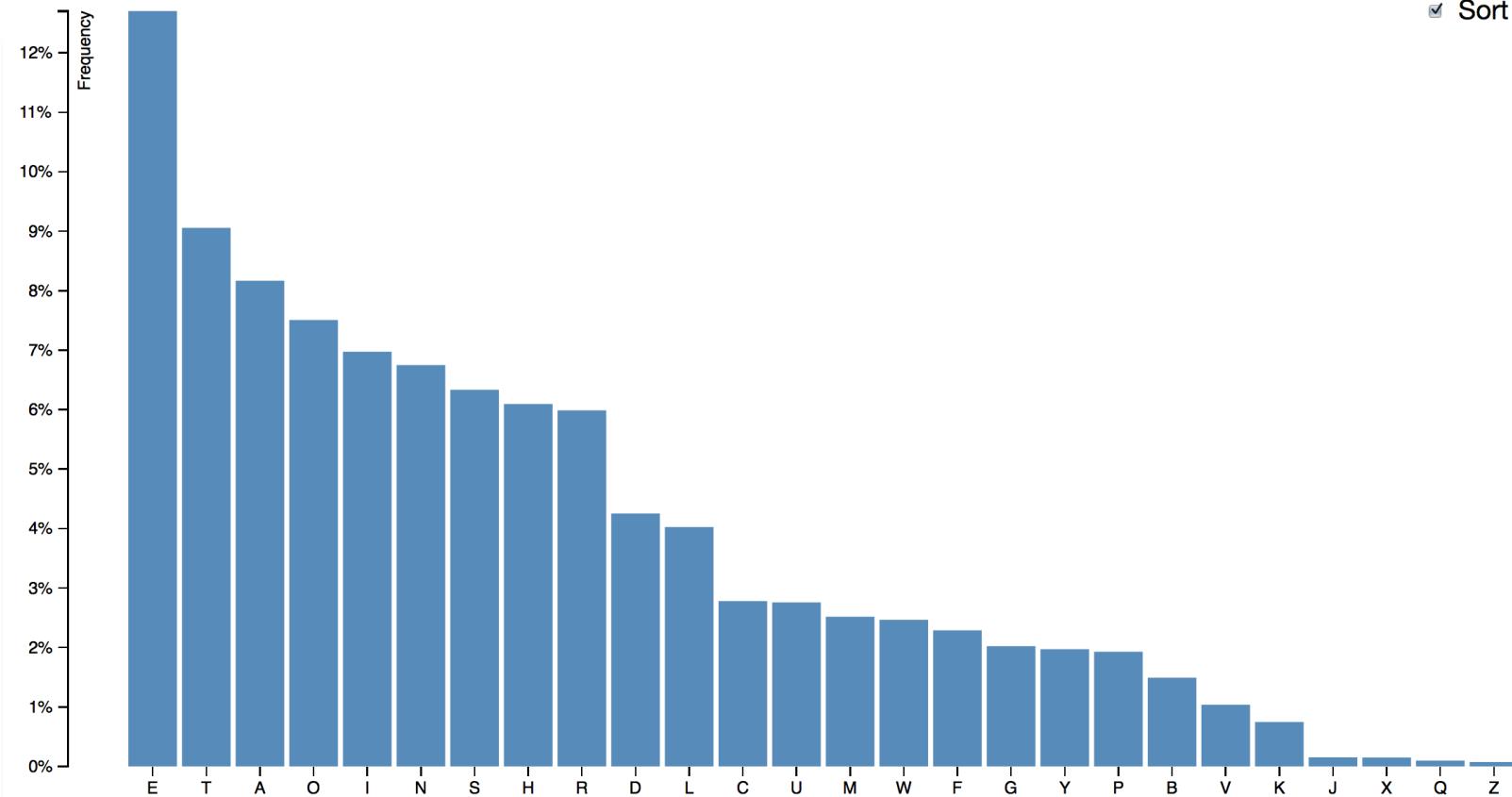
<http://bl.ocks.org/mbostock/1667367>

# DATA TRANSFORMATIONS

## Transformable Representations

# Transformable Representations

- Transform **underlying dataset** in some way
  - Sorting, filtering, clustering, drill down, *and more...*
- Visualizations can be both **transformable** and **manipulable**

Sort values

<http://bl.ocks.org/mbostock/3885705>

*Click a column header to sort.*

State	Monthly premiums for a family of four with an income of ... ▲	A 27-year-old individual who makes ...		
	... more than \$94,200 a year, ineligible for subsidies	\$50,000 a year and getting subsidies	... more than \$45,960 a year	\$25,000 a year and getting subsidies
<b>Average, 36 States</b>	<b>\$774</b>	<b>\$282</b>	<b>\$214</b>	<b>\$145</b>
Tennessee	584	282	161	145
Arizona	600	282	166	145
Kansas	619	282	171	145
Oklahoma	634	282	175	145
Utah	656	282	203	145
New Mexico	672	282	186	145
Pennsylvania	675	282	187	145
Idaho	680	282	188	145
Illinois	682	282	188	145
Iowa	683	282	189	145
Texas	727	282	201	145
Michigan	731	282	202	145
Nebraska	744	282	206	145
Montana	753	282	208	145
Alabama	757	282	209	145
Ohio	768	282	212	145
Florida	789	282	218	145
West Virginia	789	282	218	145
Missouri	798	282	220	145
Virginia	799	282	221	145
Georgia	800	282	221	145
South Carolina	809	282	223	145
North Dakota	841	282	232	145
South Dakota	852	282	235	145

<http://www.nytimes.com/interactive/2013/09/24/us/health-care-premiums.html>



Order: **by Frequency** ▼

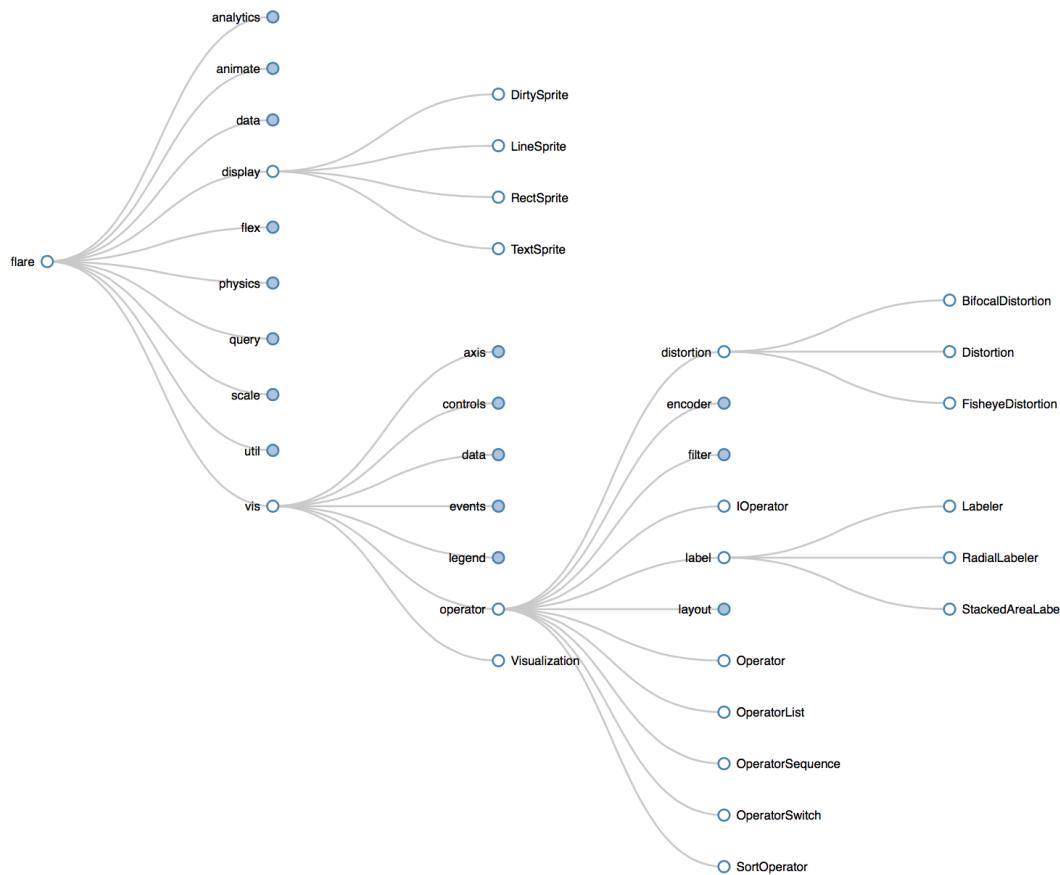
This matrix diagram visualizes  
character co-occurrences  
in Victor Hugo's *Les Misérables*.

Each colored cell represents  
two characters that appeared in  
the same chapter; darker cells  
indicate characters that co-  
occurred more frequently.

Use the drop-down menu to  
reorder the matrix and explore  
the data.

Built with [d3.js](#).

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



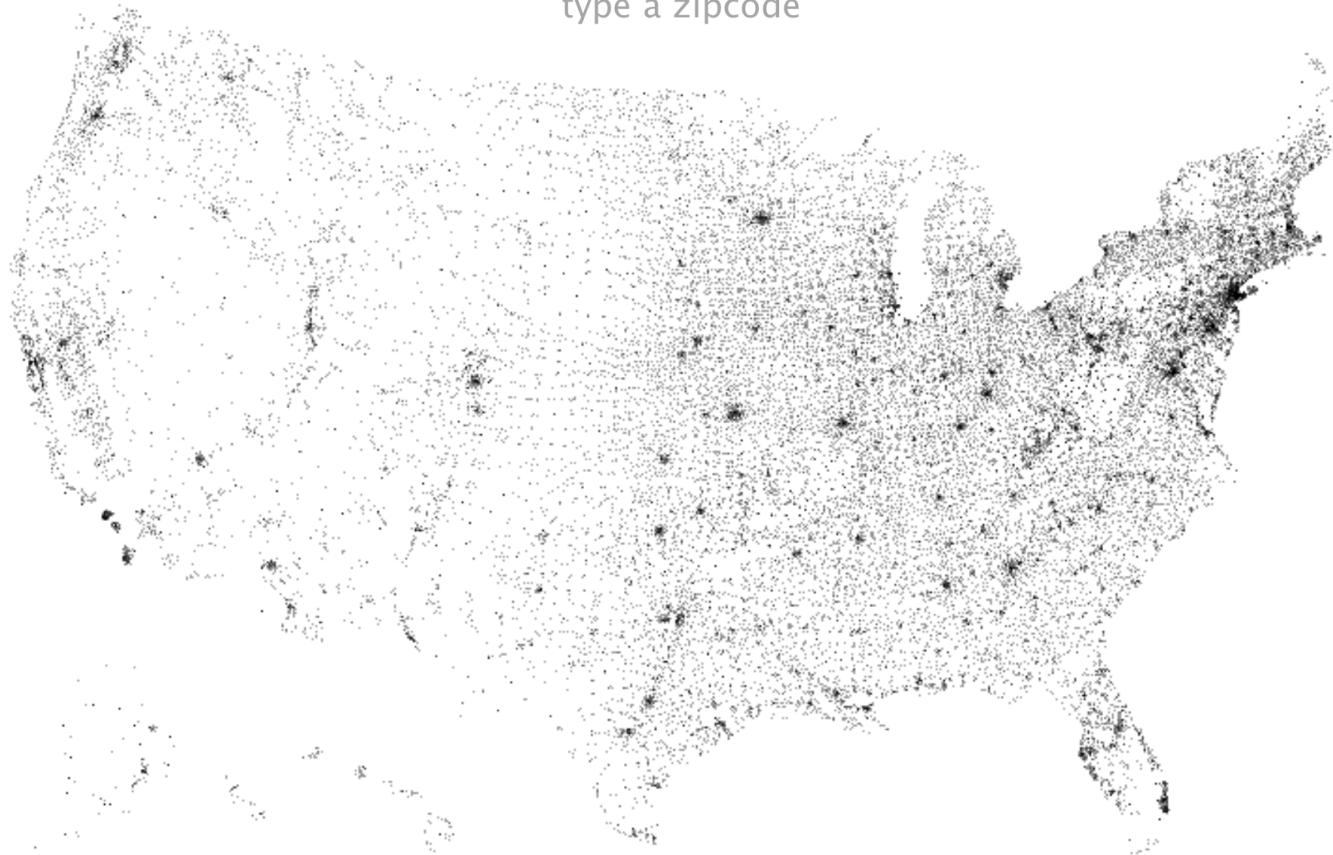
<http://bl.ocks.org/mbostock/4339083>

# EXAMPLES

Data: Drill Down, Filtering, Sorting

View: Overview + Detail, Focus + Context

type a zipcode



<http://bl.ocks.org/mbostock/5180185>



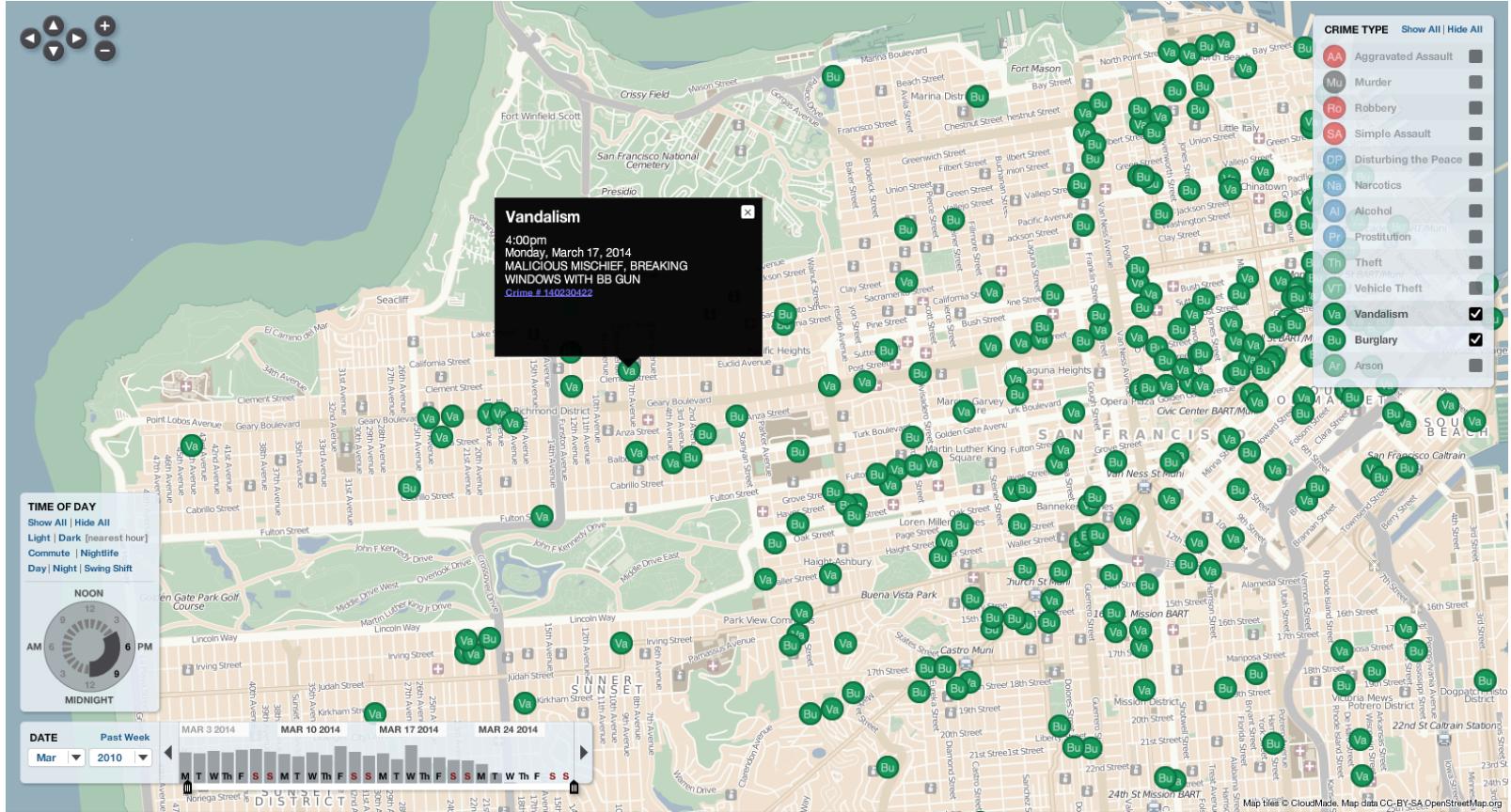
## Affluent households are earning more — and paying a larger share of taxes.

For each income bracket, its share of nation's — income and — population.

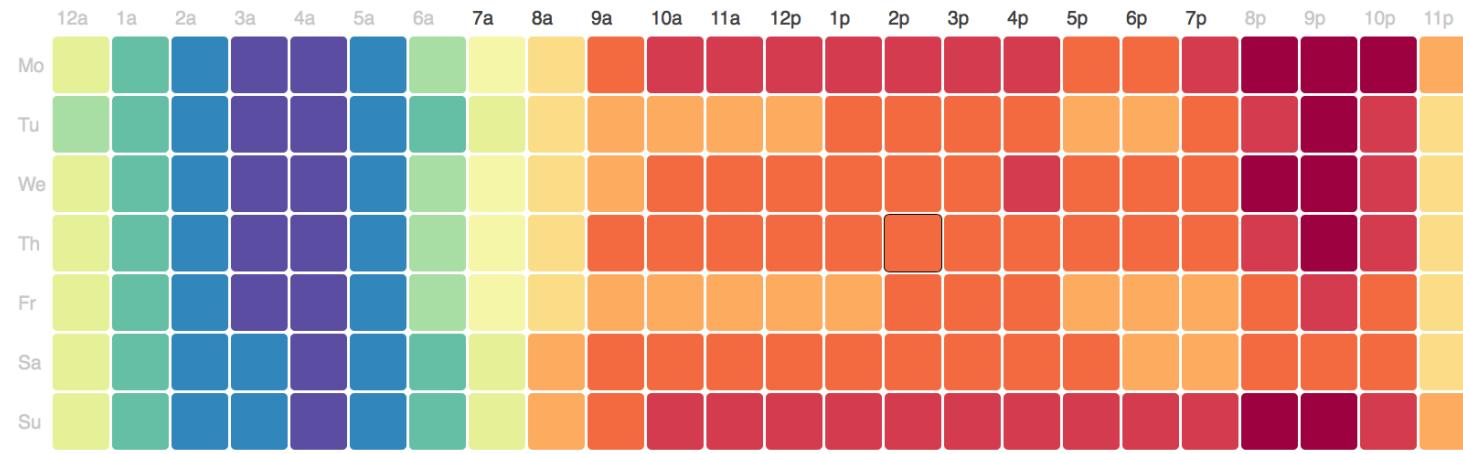


The number of high-income households, and their average income, has increased rapidly. Even in the wake of the recession, more than a million taxpayers made at least \$350,000 in 2010, and that group accounted for 15 percent of the nation's income. As a result, while those households paid a smaller share of their income in taxes than they did in 1980, they paid a larger share of the total tax bill.

<http://www.nytimes.com/interactive/2012/11/30/us/tax-burden.html>



<http://sanfrancisco.crimespotting.org>



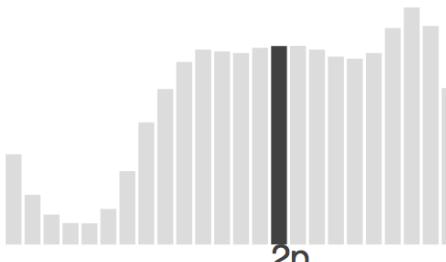
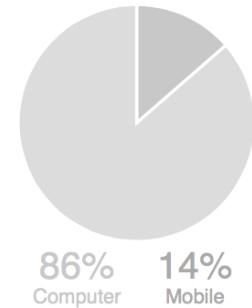
All Traffic

Computer Mobile

All States

## California

powered by  

All traffic on Thursdays

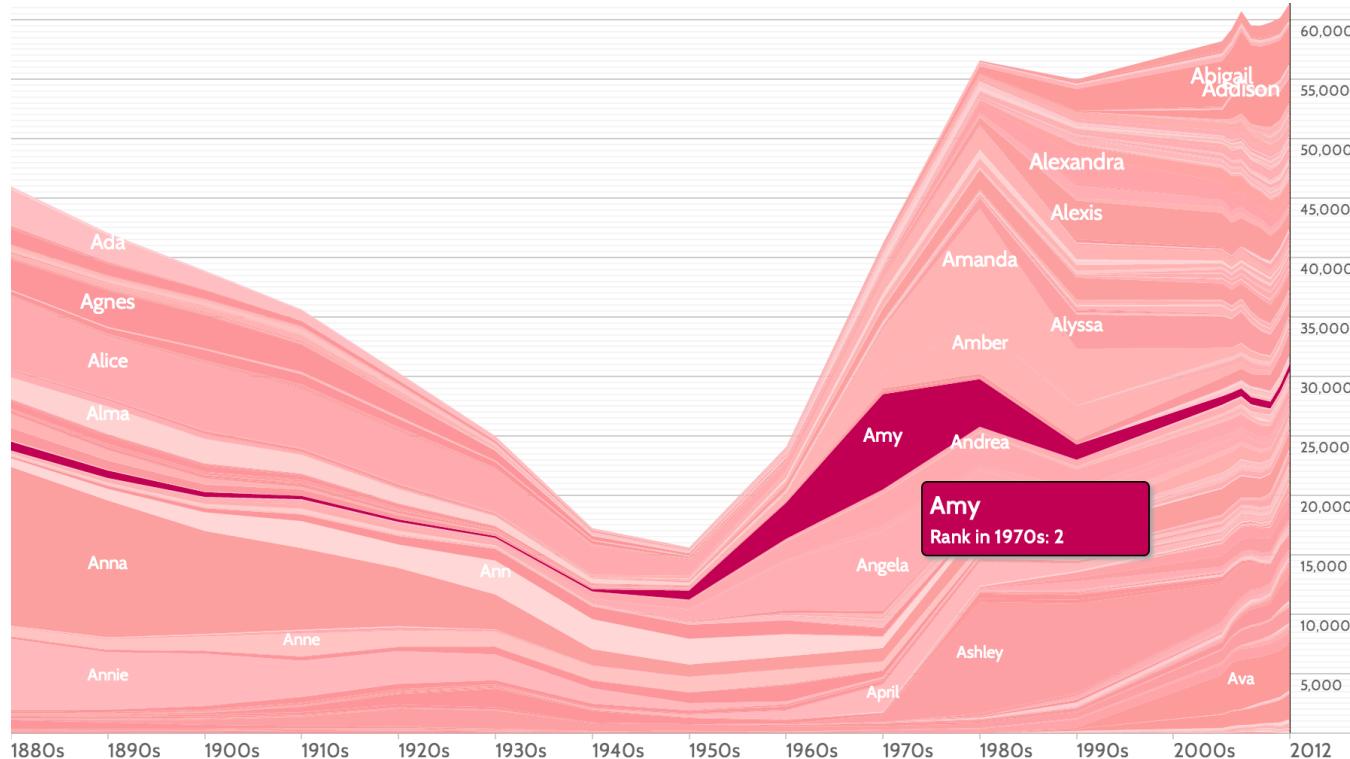
<http://www.trulia.com/trends/vis/tru247/>

Baby Name &gt; A

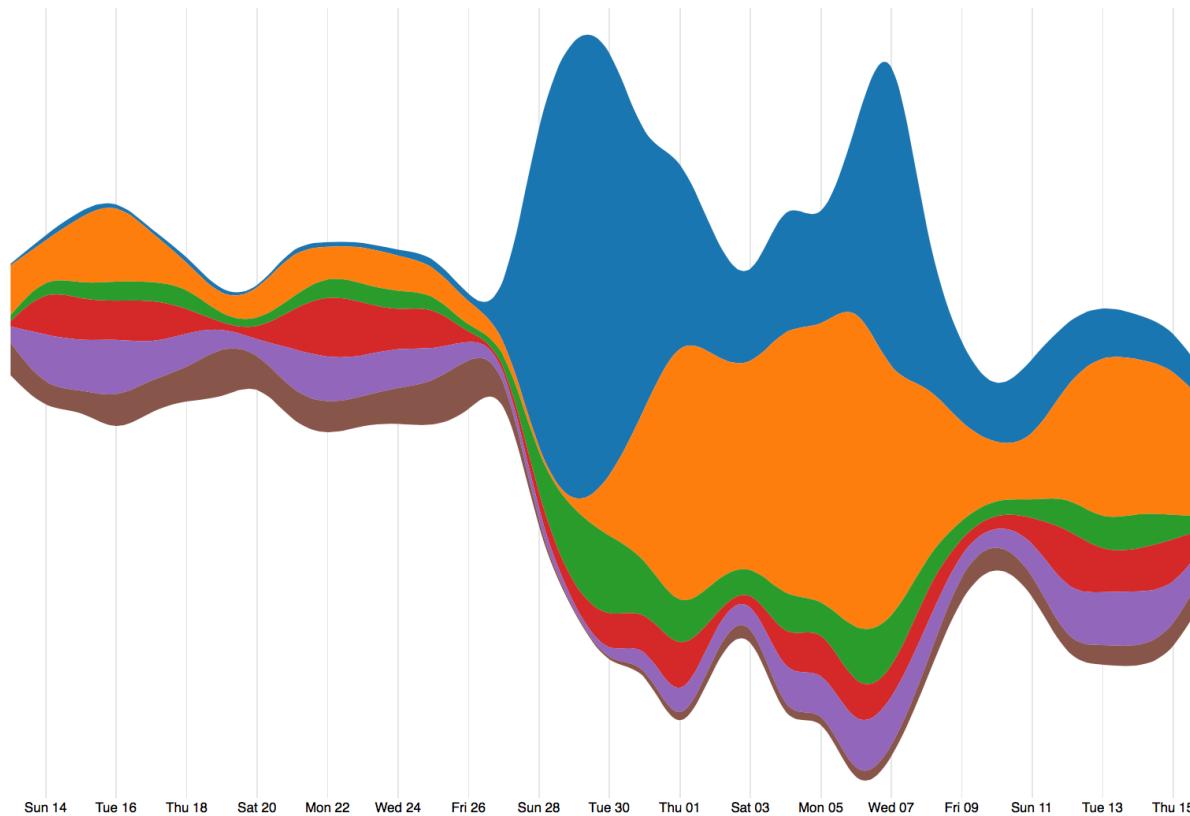
 Both
  Boys
  Girls

Current rank: boys 1000 500 100 25 1  
 girls 1000 500 100 25 1

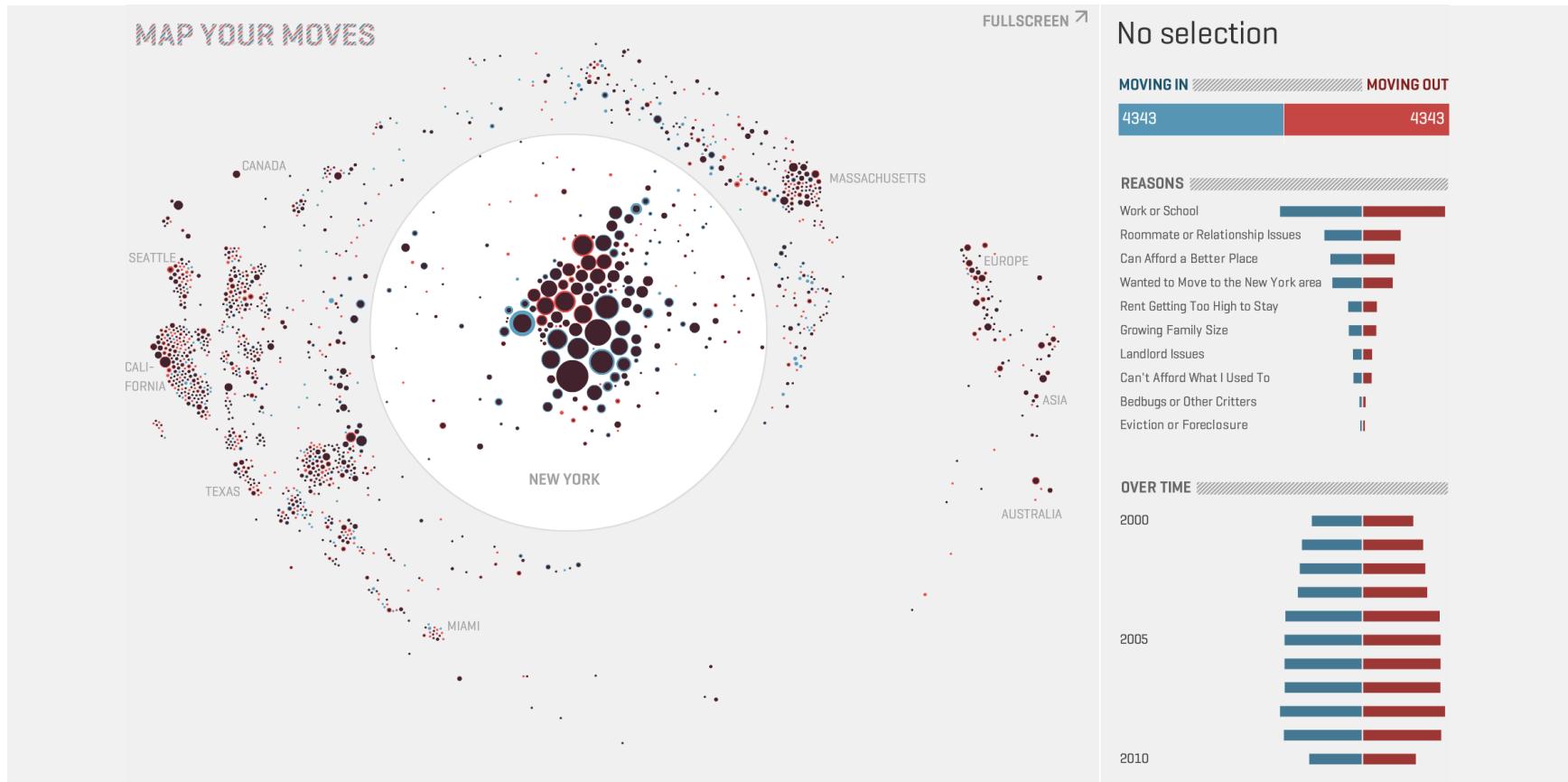
Names starting with 'A' per million babies


<http://www.babynamewizard.com/>

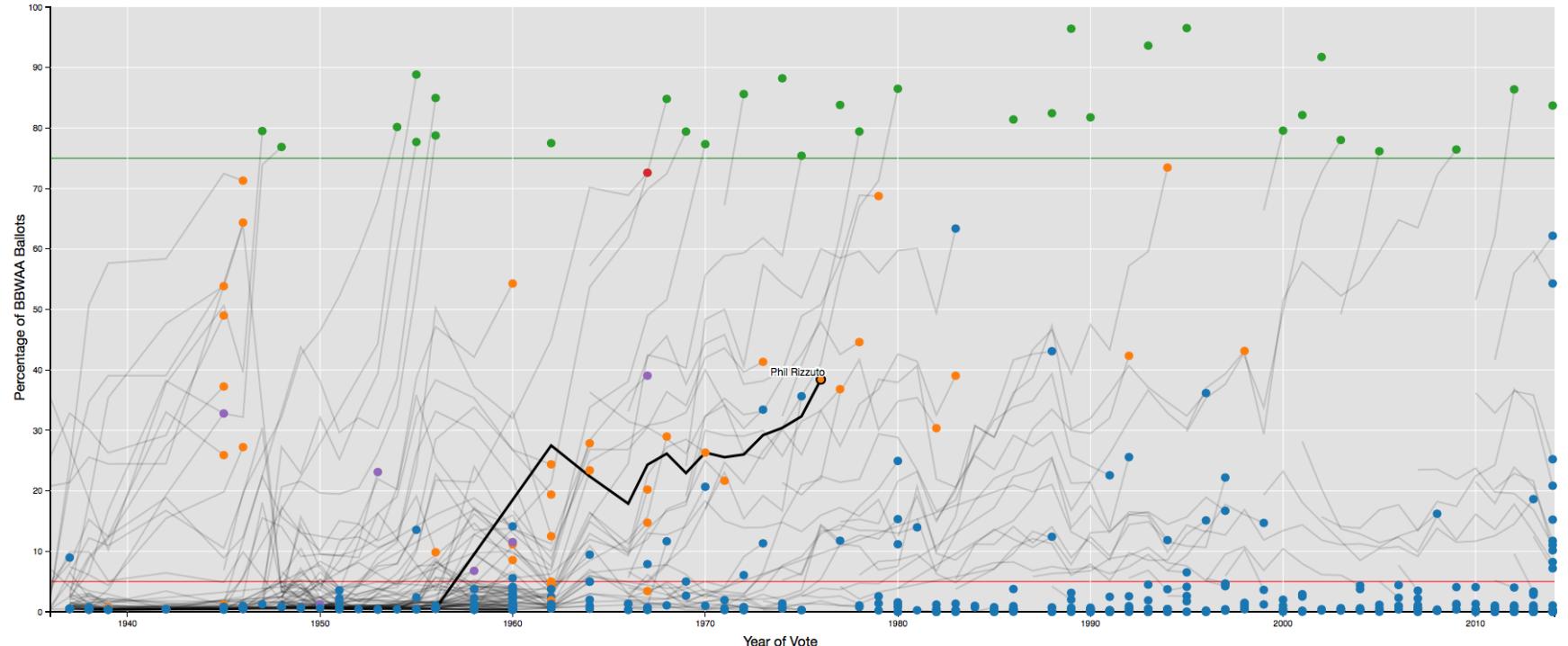
Streamgraph | Stacked Area | Area



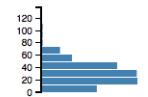
[http://projects.flowingdata.com/tut/chart\\_transitions\\_demo/](http://projects.flowingdata.com/tut/chart_transitions_demo/)



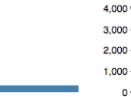
<http://moritz.stefaner.eu/projects/map%20your%20moves/>



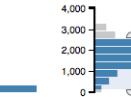
[hide](#)  
WAR



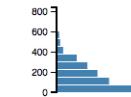
[hide](#)  
W



[hide](#)  
SO



[hide](#)  
H



[hide](#)  
HR



[hide](#)  
BA



<http://cscheid.net/static/mlb-hall-of-fame-voting/>

# Resources

- Stephen Few, "Now You See It: Simple Visualization Techniques for Quantitative Analysis," Analytics Press, California, 2009.
- Riccardo Mazza, "Introduction to Information Visualization," Springer-Verlag, London, 2009.
- Andy Cockburn, Amy Karlson, and Benjamin B. Bederson, "A Review of Overview+Detail, Zooming, and Focus+Context Interfaces," ACM Computing Surveys, Volume 41, Number 1, Article 2, December 2008.
- Jeffery Heer and Ben Shneiderman, "Interactive Dynamics for Visual Analytics," ACM Queue, Volume 10, Number 2, February 2012.

# QUESTIONS

<http://sjengle.cs.usfca.edu/>