

Data visualization

Visualization of data

- What is it good for?
- What is its function?

helps understand the significance of data by placing it in a visual context

allows us visual access to huge amounts of data in easily digestible visuals

So that we can do *something* with the data (predict, apply, fix, change, enhance, identify, clarify, etc.)

Charles Minard. Napoleon's March in Russia 1812

Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Dessinée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; il somme de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. Chier, de Séguir, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout qui avaient été détachés sur Minsk et Mogilow et qui rejoignirent Orsha et Vitebsk, avaient toujours marché avec l'armée.

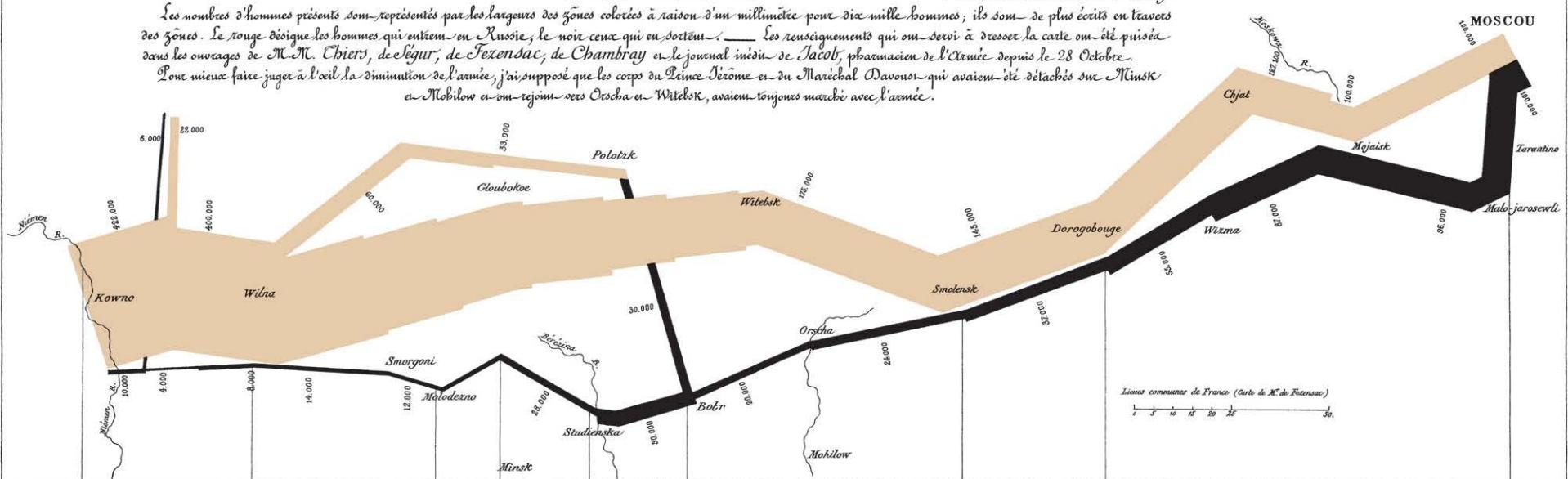


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

Les cosaques passent au galop
le Niemen gelé.





Charles Minard. Napoleon's March in Russia 1812



Charles Minard. Napoleon's March in Russia 1812



Charles Minard. Napoleon's March in Russia 1812



Charles Minard. Napoleon's March in Russia 1812



Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessinée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite

Paris, le 20 Novembre 1869.

422,000 French Troops Started March to Russia.

1

Captures multivariate complexity (size of army, location, direction, temperature, and time).

2

2.37% of Napoleon's army survived the battle.

2

10,000 French Troops Returned from Russia.

Forces visual comparisons where the upper lighter band showing the large French army marching to Moscow vs. the narrow dark band showing the much smaller French army retreating.

Les cosaques passent le Niémen gelé.

— 26. le 7 X.^{bre}

— 26. le 6 X.^{bre}

— 24. le 1^{er} X.^{bre} — 20. le 28 9.^{bre}
— 11°

Shows partial causality (the temperature line chart above). However, there are more reasons than temperature why Napoleon lost the battle.

4

Illustrates high quality content comprised of complete and accurate data, presented to support Minard's argument against war.

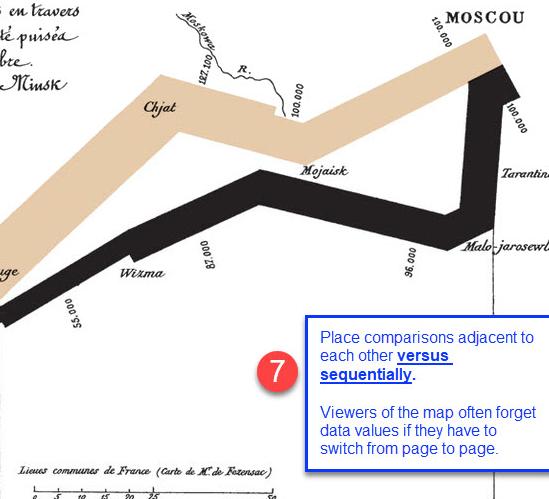
5

Integrates text and graphic into a coherent whole.

7

Place comparisons adjacent to each other versus sequentially.

Viewers of the map often forget data values if they have to switch from page to page.



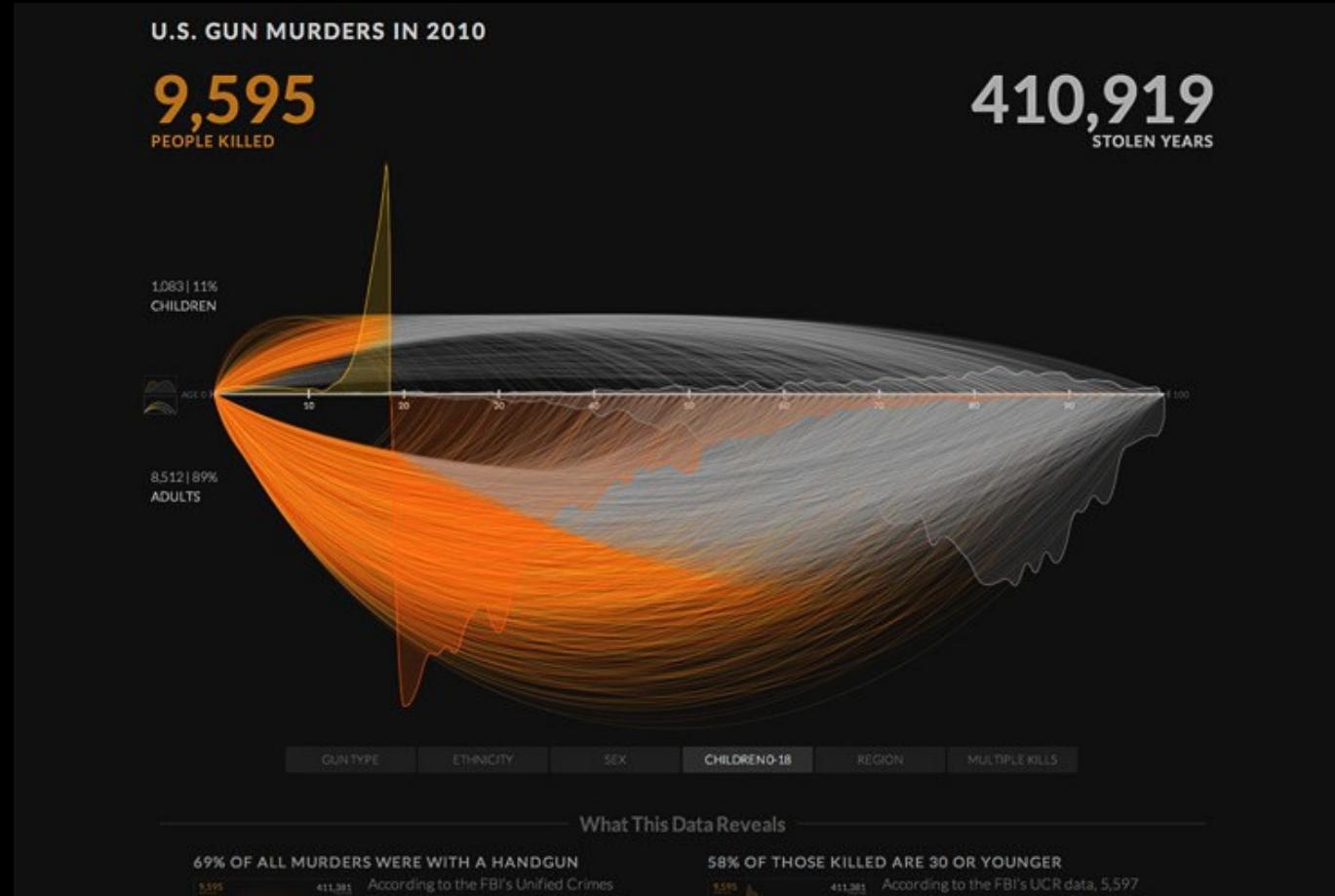
Use the smallest effective difference. Avoid bold colors, heavy lines, distracting labels and scales.

3

Lieux communs de France (Carte de M. de Roncisz)

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 101 103 105 107 109 111 113 115 117 119 121 123 125 127 129 131 133 135 137 139 141 143 145 147 149 151 153 155 157 159 161 163 165 167 169 171 173 175 177 179 181 183 185 187 189 191 193 195 197 199 201 203 205 207 209 211 213 215 217 219 221 223 225 227 229 231 233 235 237 239 241 243 245 247 249 251 253 255 257 259 261 263 265 267 269 271 273 275 277 279 281 283 285 287 289 291 293 295 297 299 301 303 305 307 309 311 313 315 317 319 321 323 325 327 329 331 333 335 337 339 341 343 345 347 349 351 353 355 357 359 361 363 365 367 369 371 373 375 377 379 381 383 385 387 389 391 393 395 397 399 401 403 405 407 409 411 413 415 417 419 421 423 425 427 429 431 433 435 437 439 441 443 445 447 449 451 453 455 457 459 461 463 465 467 469 471 473 475 477 479 481 483 485 487 489 491 493 495 497 499 501 503 505 507 509 511 513 515 517 519 521 523 525 527 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Data visualization. U.S. Gun Murders 2010-2013



Data visualization. Shanghai Metro Flow by Till Nagel



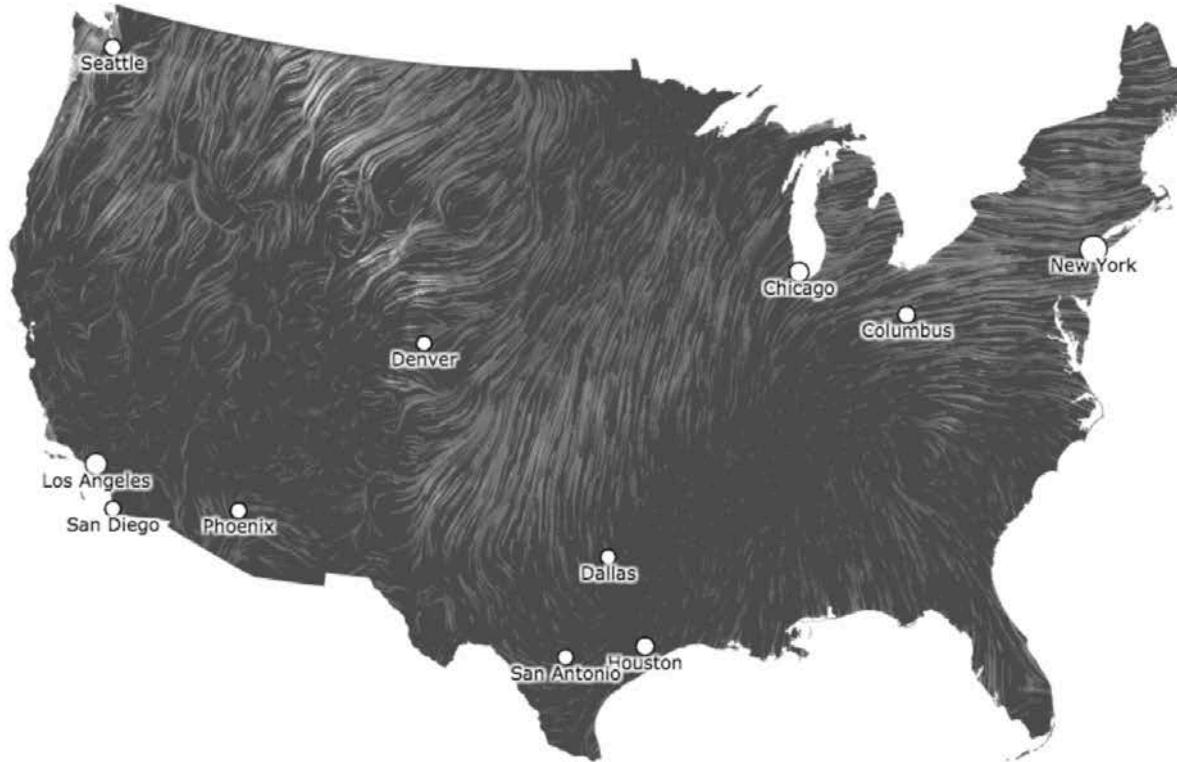
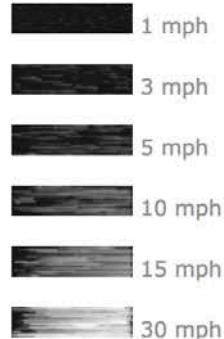
Data visualization. Wind map by

Nov. 19, 2017

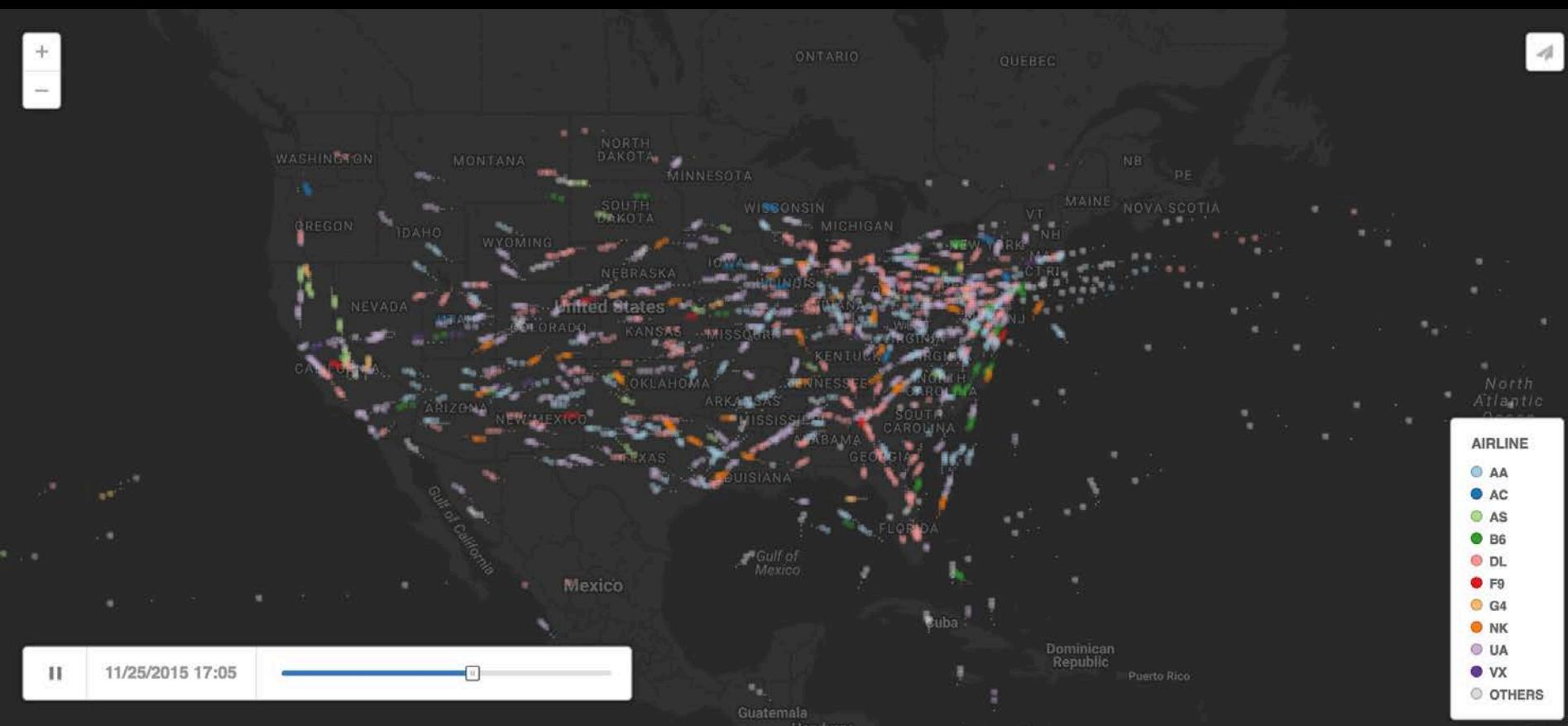
10:37 pm EST

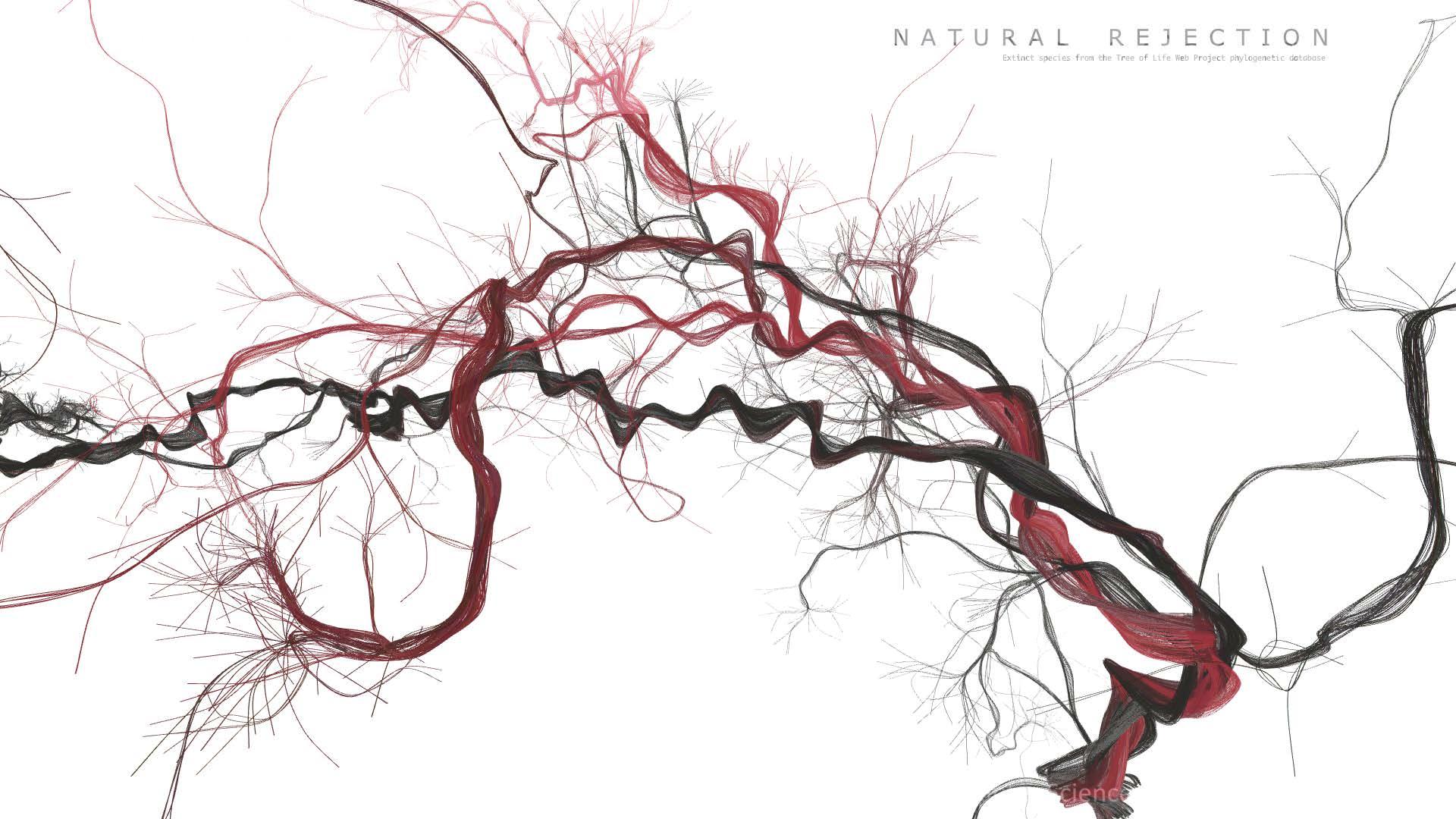
(time of forecast download)

top speed: **53.9 mph**
average: **9.7 mph**



Data visualization. US Thanksgiving on Google Flights 2015

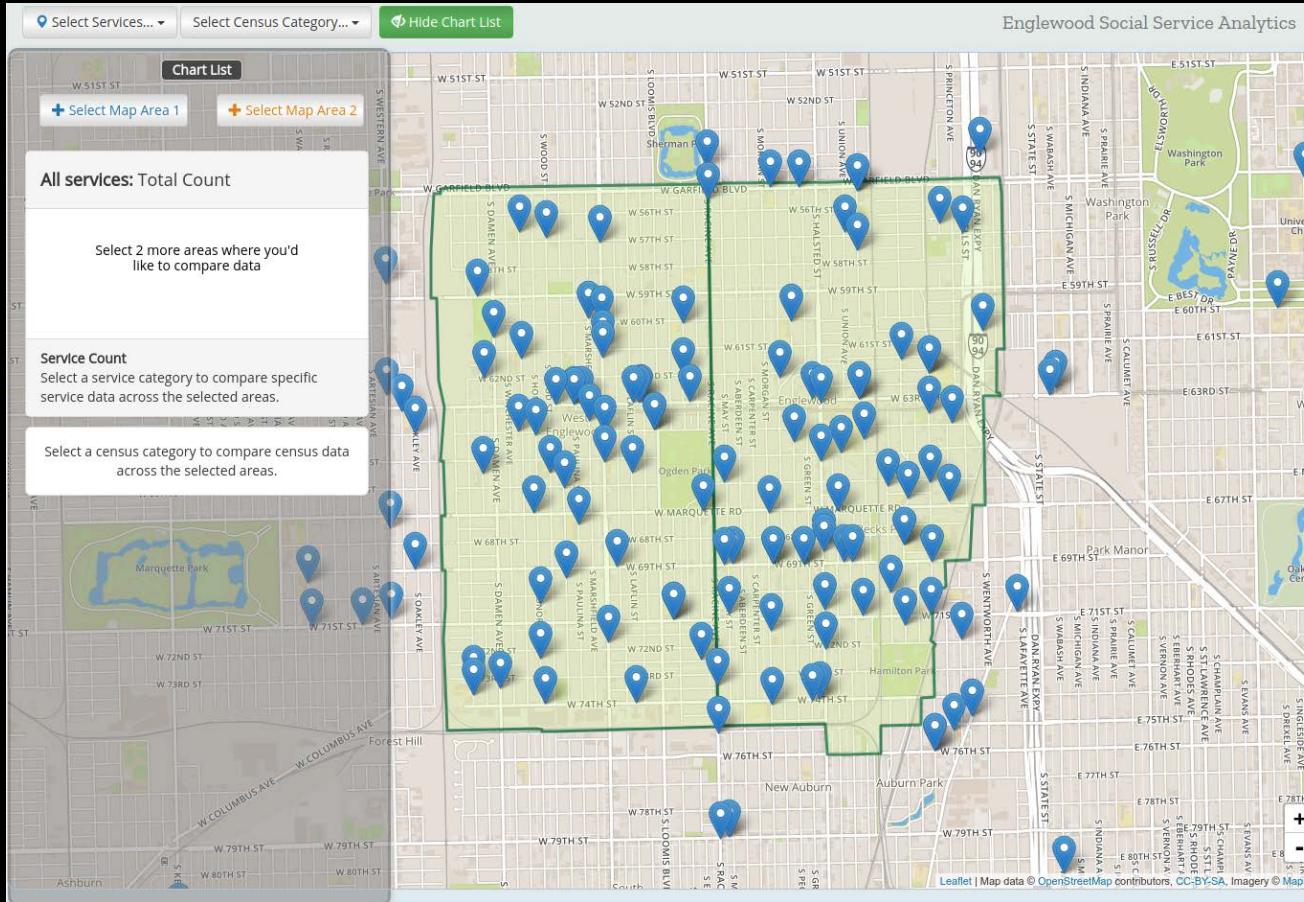




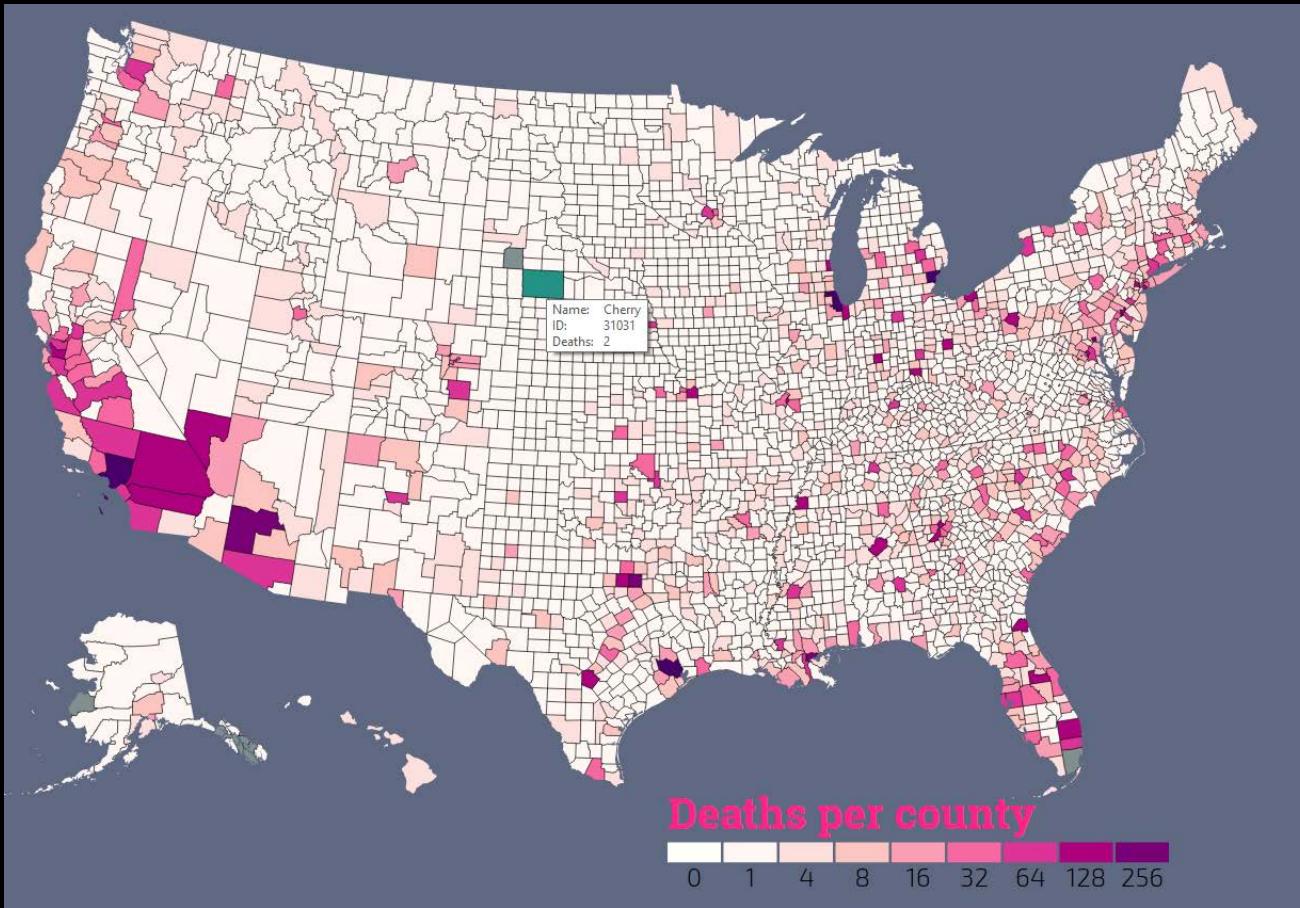
NATURAL REJECTION

Extinct species from the Tree of Life Web Project phylogenetic database

Data visualization. Englewood Social Service



Data visualization. Gun deaths in U.S.



Data-Driven Documents (D3)

A JavaScript library

Web visualizations

Version 4 modular – 2016

DOM

HTML5, JavaScript, CSS

SVG - Scalable Vector Graphics

Document Object Model (DOM)

Web browser renders a web page by rendering the DOM

Components of a web program:

- HTML – structure of the DOM
- CSS – styling the DOM
- JS – interacting with + dynamically updating the DOM
- JSON – loading in data used by JS to update the DOM

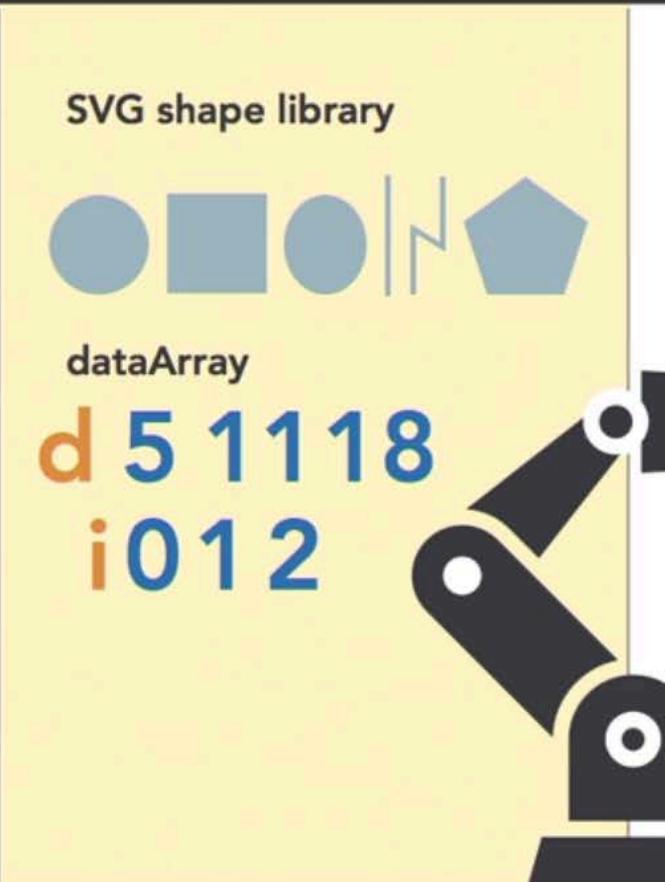
Special DOM/ HTML5 elements:

SVG - Scalable Vector Graphics / Canvas

D3 Code

```
var sel = svg.selectAll("rect")
  .data(dataArray)
  .enter().append("rect")
  .attr("height", function(d){
    return d*15;
  })
  .attr("width", 50)
  .attr("fill", "pink")
  .attr("x", function(d,i){
    return i*60;
  });
  .attr("y", function (d,i) {
    return 300 - (d*15);
 });
```

Inputs



Outputs



D3 intro

d data point [5, 11, 18]

```
var dataArray = [5,11,18];
```

| index 0, 1, 2...

SVG elements – circle, line, polyline, rectangle, ellipse, polygon, paths

How to work

Atom text editor

How to debug:

- Firefix Developer Edition (former Firebug) / browser's console
- Using JSBin (<http://jsbin.com/cogagi/1/edit?html,js,console>)

D3 built-in data handlers

D3 data handlers allow to pull data in from a database or file.

HTML - hyper text markup language

CSV – comma-separated values

TSV – tab-separated values

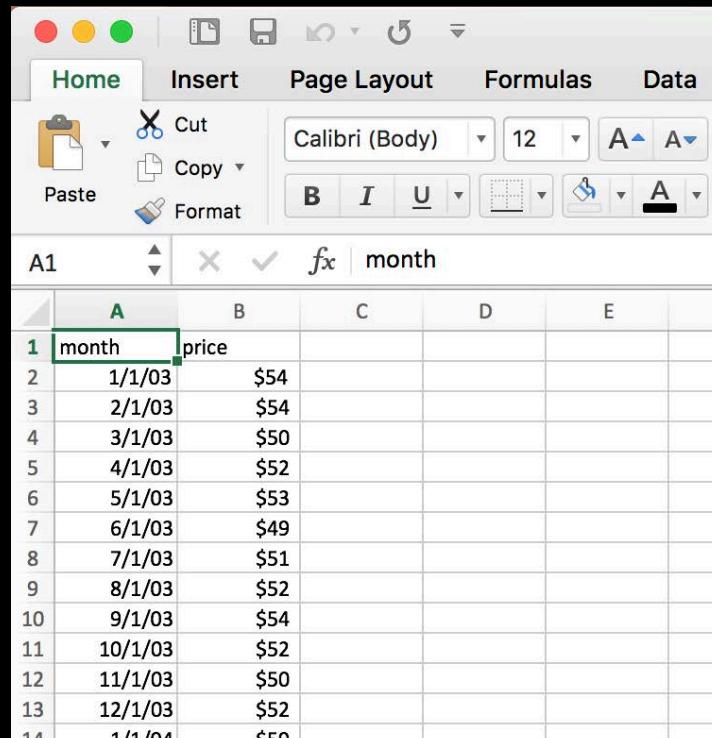
DSV – data source view

XML – eXtensible markup language

JSON – JavaScript object notation

Text files

Custom



A screenshot of Microsoft Excel showing a data table. The table has two columns: 'month' and 'price'. The data starts at row 1 and continues through row 14. The 'month' column contains dates from 1/1/03 to 1/1/04. The 'price' column contains values ranging from \$49 to \$54. The table is selected, and the formula bar shows 'fx month'.

| | A | B | C | D | E |
|----|---------|-------|---|---|---|
| 1 | month | price | | | |
| 2 | 1/1/03 | \$54 | | | |
| 3 | 2/1/03 | \$54 | | | |
| 4 | 3/1/03 | \$50 | | | |
| 5 | 4/1/03 | \$52 | | | |
| 6 | 5/1/03 | \$53 | | | |
| 7 | 6/1/03 | \$49 | | | |
| 8 | 7/1/03 | \$51 | | | |
| 9 | 8/1/03 | \$52 | | | |
| 10 | 9/1/03 | \$54 | | | |
| 11 | 10/1/03 | \$52 | | | |
| 12 | 11/1/03 | \$50 | | | |
| 13 | 12/1/03 | \$52 | | | |
| 14 | 1/1/04 | \$50 | | | |

D3 data vis

D3.html

prices.js

prices.csv

| | A | B | C | D | E |
|----|---------|-------|---|---|---|
| 1 | month | price | | | |
| 2 | 1/1/03 | \$54 | | | |
| 3 | 2/1/03 | \$54 | | | |
| 4 | 3/1/03 | \$50 | | | |
| 5 | 4/1/03 | \$52 | | | |
| 6 | 5/1/03 | \$53 | | | |
| 7 | 6/1/03 | \$49 | | | |
| 8 | 7/1/03 | \$51 | | | |
| 9 | 8/1/03 | \$52 | | | |
| 10 | 9/1/03 | \$54 | | | |
| 11 | 10/1/03 | \$52 | | | |
| 12 | 11/1/03 | \$50 | | | |
| 13 | 12/1/03 | \$52 | | | |
| 14 | 1/1/04 | \$59 | | | |
| 15 | 2/1/04 | \$60 | | | |
| 16 | 3/1/04 | \$61 | | | |
| 17 | 4/1/04 | \$59 | | | |
| 18 | 5/1/04 | \$60 | | | |
| 19 | 6/1/04 | \$64 | | | |
| 20 | 7/1/04 | \$58 | | | |

prices.js

```
d3.csv("prices.csv")
.get(function(error, data){
  console.log(data);
})
```

The screenshot shows a browser's developer tools interface with the 'Console' tab selected. Below the tabs, there are icons for Clear, Filter output, and a dropdown menu labeled '[...]' which is expanded to show the first eight items of the parsed CSV data.

| Index | Month | Price |
|-------|----------|-------|
| 0 | 1/1/2003 | \$54 |
| 1 | 2/1/2003 | \$54 |
| 2 | 3/1/2003 | \$50 |
| 3 | 4/1/2003 | \$52 |
| 4 | 5/1/2003 | \$53 |
| 5 | 6/1/2003 | \$49 |
| 6 | 7/1/2003 | \$51 |
| 7 | 8/1/2003 | \$52 |

prices.js

```
var parseDate= d3.timeParse("%m/%d/%Y");

d3.csv("prices.csv")
  .row(function(d){ return {month: parseDate(d.month),
    price:Number(d.price.trim().slice(1))}; })
  .get(function(error, data){
    console.log(data);
  })
  .get(function(error, data){
    console.log(data);
  })
```

The screenshot shows a browser's developer tools interface with the 'Console' tab selected. The console output displays the parsed CSV data as an array of objects. Each object represents a month and its corresponding price, with the price being a floating-point number.

```
[...]
▶ 0: Object { month: Date 2003-01-01T06:00:00.000Z, price: 54 }
▶ 1: Object { month: Date 2003-02-01T06:00:00.000Z, price: 54 }
▶ 2: Object { month: Date 2003-03-01T06:00:00.000Z, price: 50 }
▶ 3: Object { month: Date 2003-04-01T06:00:00.000Z, price: 52 }
▶ 4: Object { month: Date 2003-05-01T05:00:00.000Z, price: 53 }
▶ 5: Object { month: Date 2003-06-01T05:00:00.000Z, price: 49 }
▶ 6: Object { month: Date 2003-07-01T05:00:00.000Z, price: 51 }
▶ 7: Object { month: Date 2003-08-01T05:00:00.000Z, price: 52 }
▶ 8: Object { month: Date 2003-09-01T05:00:00.000Z, price: 54 }
▶ 9: Object { month: Date 2003-10-01T05:00:00.000Z, price: 52 }
▶ 10: Object { month: Date 2003-11-01T06:00:00.000Z, price: 50 }
```

prices.js

```
var parseDate= d3.timeParse("%m/%d/%Y");

d3.csv("prices.csv")
  .row(function(d){ return {month: parseDate(d.month),
  price:Number(d.price.trim().slice(1))}; })
  .get(function(error, data){


```

```
var height= 300;
```

```
var width = 500;
```

prices.js

```
var max = d3.max(data, function(d) {return d.price; });

var minDate = d3.min (data, function(d) {return d.month;});

var maxDate = d3.max (data, function(d) {return d.month;});

var y = d3.scaleLinear()
    .domain([0, max])
    .range([height, 0]);

var x = d3.scaleTime()
    .domain([minDate, maxDate])
    .range([0, width]);
```

prices.js

```
var yAxis = d3.axisLeft(y);
var xAxis = d3.axisBottom(x);

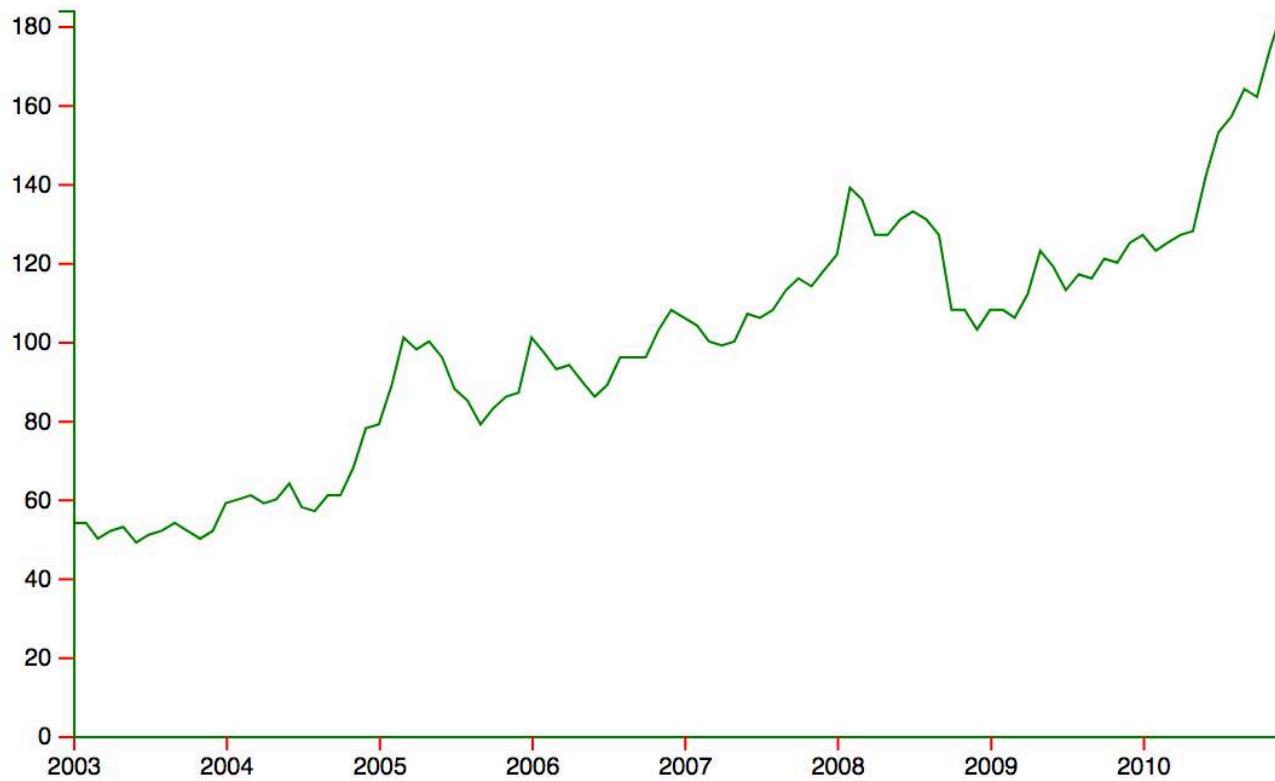
var svg = d3.select("body").append("svg").attr("height",
"100%").attr("width", "100%");

var margin = {left:50,right:50,top:40,bottom:0};
var chartGroup = svg.append("g")
    .attr("transform", "translate("+margin.left+", "+margin.top+")");
```

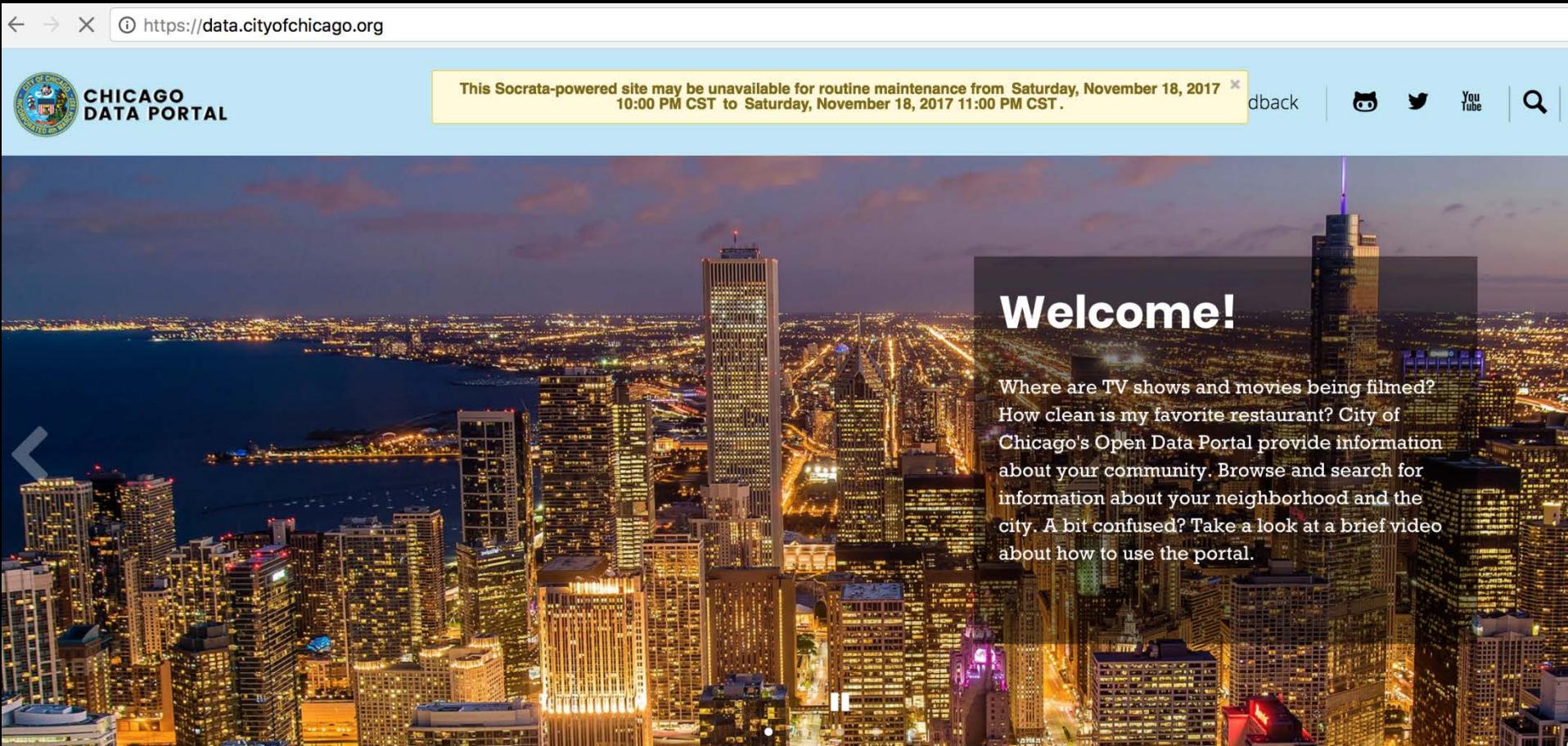
prices.js

```
var line = d3.line()  
  .x(function(d){ return x(d.month); })  
  .y(function(d){ return y(d.price); });  
  
chartGroup.append("path").attr("d", line(data));  
chartGroup.append("g").attr("class", "x axis")  
  .attr("transform", "translate(0, "+height+")").call(xAxis);  
chartGroup.append("g").attr("class", "y axis").call(yAxis);  
});
```

prices.js



Datasets

A wide-angle, nighttime photograph of the Chicago skyline, featuring numerous skyscrapers illuminated against a dark sky. The city extends towards a body of water on the left.

<https://data.cityofchicago.org>

This Socrata-powered site may be unavailable for routine maintenance from Saturday, November 18, 2017 10:00 PM CST to Saturday, November 18, 2017 11:00 PM CST.

CHICAGO DATA PORTAL

dback

Welcome!

Where are TV shows and movies being filmed? How clean is my favorite restaurant? City of Chicago's Open Data Portal provide information about your community. Browse and search for information about your neighborhood and the city. A bit confused? Take a look at a brief video about how to use the portal.

Datasets

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DATASETS

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the front page of the internet.

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self.datasets

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dataset | [\[Dataset\] Cryptocurrency Historical Data \(Top 50\)](#) kaggle.com

Submitted an hour ago by [jackraddit](#)



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Browse Through: 394 Data Sets

Table View List View

| Default Task | Name | Data Types | Default Task | Attribute Types | # Instances | # Attributes | Year |
|----------------------|--|--------------|---------------------|----------------------------|-------------|--------------|------|
| Classification (289) |  Abalone | Multivariate | Classification | Categorical, Integer, Real | 4177 | 8 | 1995 |
| Regression (74) |  Adult | Multivariate | Classification | Categorical, Integer | 48842 | 14 | 1996 |
| Clustering (67) |  Annealing | Multivariate | Classification | Categorical, Integer, Real | 798 | 38 | |
| Other (54) |  Anonymous Microsoft Web Data | | Recommender-Systems | Categorical | 37711 | 294 | 1998 |
| Categorical (37) |  Arrhythmia | Multivariate | Classification | Categorical, Integer, Real | 452 | 279 | 1998 |
| Numerical (244) |  Artificial Characters | Multivariate | Classification | Categorical, Integer, Real | 6000 | 7 | 1992 |
| Mixed (55) | | | | | | | |

Datasets

← → ⌂ wordnet.princeton.edu

PRINCETON UNIVERSITY Search

WordNet

A lexical database for English



What is WordNet?

| | | |
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| People | | We get numerous questions regarding topics that are addressed on our FAQ page. If you have a problem or |
| News | | |
| Use WordNet online | <p>When writing a paper or producing a software application, tool, or interface based on WordNet, it is necessary to properly cite the source. Citation figures are critical to WordNet funding.</p> | |

Chicago streets data from Chicago Data Portal

chicagoStreets.js

```
1
2 d3.csv("Chicago_Street_Names.csv").get(function(error, data){
3   console.log(data);
4 });
5
```

Inspector Console Debugger Style Editor Performance Memory Network Storage

Filter output

```
[...]
[0..99]
▶ 0: Object { streetName: "E 100TH PL", Direction: "E", "Street": "100TH", ... }
▶ 1: Object { streetName: "W 100TH PL", Direction: "W", "Street": "100TH", ... }
▶ 2: Object { streetName: "E 100TH ST", Direction: "E", "Street": "100TH", ... }
▶ 3: Object { streetName: "W 100TH ST", Direction: "W", "Street": "100TH", ... }
▶ 4: Object { streetName: "E 101ST PL", Direction: "E", "Street": "101ST", ... }
▶ 5: Object { streetName: "W 101ST PL", Direction: "W", "Street": "101ST", ... }
▶ 6: Object { streetName: "E 101ST ST", Direction: "E", "Street": "101ST", ... }
▶ 7: Object { streetName: "W 101ST ST", Direction: "W", "Street": "101ST", ... }
▶ 8: Object { streetName: "E 102ND PL", Direction: "E", "Street": "102ND", ... }
▶ 9: Object { streetName: "W 102ND PL", Direction: "W", "Street": "102ND", ... }
```

D3 data vis

Use D3 to transform the data into an SVG visualization

visualization responds when data is updated

uses a functional style of programming, which can be a bit confusing,
but makes it easy to compose data transformations

D3 exercise

Explore <https://bl.ocks.org>

Choose a block – replace with a small subset of your data

The screenshot shows the homepage of bl.ocks.org. At the top, there's a navigation bar with icons for back, forward, refresh, and search, followed by a secure connection indicator and the URL "Secure | https://bl.ocks.org". To the right of the URL are links for "Popular / About" and other site navigation.

The main content area is titled "Popular Blocks" and shows the date "Updated November 18, 2017 10AM". Below this, there are ten cards, each representing a different D3.js visualization:

- Fantasy Map Generator** by Azgaar: A heatmap visualization on a purple background.
- Bubble Chart** by mbostock: A bubble chart with many colored bubbles of varying sizes.
- Bar Chart** by mbostock: A standard bar chart with blue bars of different heights.
- Force-Directed Graph** by mbostock: A network graph where nodes are connected by lines of varying thickness.
- Sequences sunburst** by kerryrodden: A sunburst chart showing hierarchical data structures.
- Stacked-to-Grouped Bars** by mbostock: A chart showing stacked bars transitioning into grouped bars.
- Radial Tidy Tree** by mbostock: A radial tree diagram where branches fan out from a central point.
- Line Chart** by mbostock: A line chart showing a fluctuating line over time.
- Choropleth** by mbostock: A map of the United States where states are colored according to a choropleth scale.
- Calendar View** by mbostock: A grid-based calendar view where cells contain small images or data.
- Histogram** by mbostock: A histogram with blue bars showing frequency distribution.
- Grouped Bar Chart** by mbostock: A grouped bar chart with multiple series of blue bars.

D3 exercise

Look over the code from class

- a) change the circles to different shapes
- b) map some of the different data fields to different visual encodings
(you could choose color, stroke, opacity, or size, etc).

You can also add new data elements to the JSON code (by cloning the jsbin.com/zozukof.json file or including it directly in your code).

Feel free to collaborate with or get help from others.

Project 2 - SpaceTime2018

SpaceTime 2018

SIGGRAPH 2018 Vancouver

<https://s2018.siggraph.org/>

Student Competition and Exhibition

<https://education.siggraph.org/conferences/annual-conference/siggraph-2018/spacetime-cfp>

Project 2 - SpaceTime2018

At SIGGRAPH 2018 theme - “Generations.”

Over the years, a long legacy of scientists, thinkers, artists, engineers, and visionaries have made SIGGRAPH the best place to experience the bleeding edge of computer animation and interactive techniques. I invite you to continue inspiring the next generation of dreamers and thinkers and submit your best work today.

The theme for SpaceTime 2018 is: “**Generations**” in keeping with the theme of 2018 conference. We are looking for posters that depict this idea.

Project 2 - SpaceTime2018

Submission Requirements:

jpg file:

- Image size is A3 (11.7" x 16.5"--297 x 420 mm) 300-ppi RGB, JPG format.
- Name your file: firstname_lastname_s2018.jpg

Word document named firstname_lastname_s2018.docx with:

- Student's name: First Name, Last Name
- Title of Work
- Student's email address
- School and Department/Program name with City and Country
- Professor's name
- A brief artist's statement (maximum 250 words) and a brief technical statement (maximum 150 words)

Project 2 - SpaceTime2018

You should not use any copyrighted imagery for your poster. You may use images released under a Creative Commons license that allows for derivative works, or images that are in the public domain.

Submission Methods:

Email attachments: one image, one statement sent to anna.ursyn [at] unco.edu, Cc: aursyn [at] gmail.com. (Please use both addresses to avoid getting lost in SPAM)

Project 2 - SpaceTime2018

SpaceTime2017 Gallery

<https://education.siggraph.org/spacetime/gallery/2017>

SpaceTime2016 Gallery

<https://education.siggraph.org/spacetime/gallery/2016>

SpaceTime2015 Gallery

<https://education.siggraph.org/spacetime/gallery/2015>