# Tips for Effective Data Visualization

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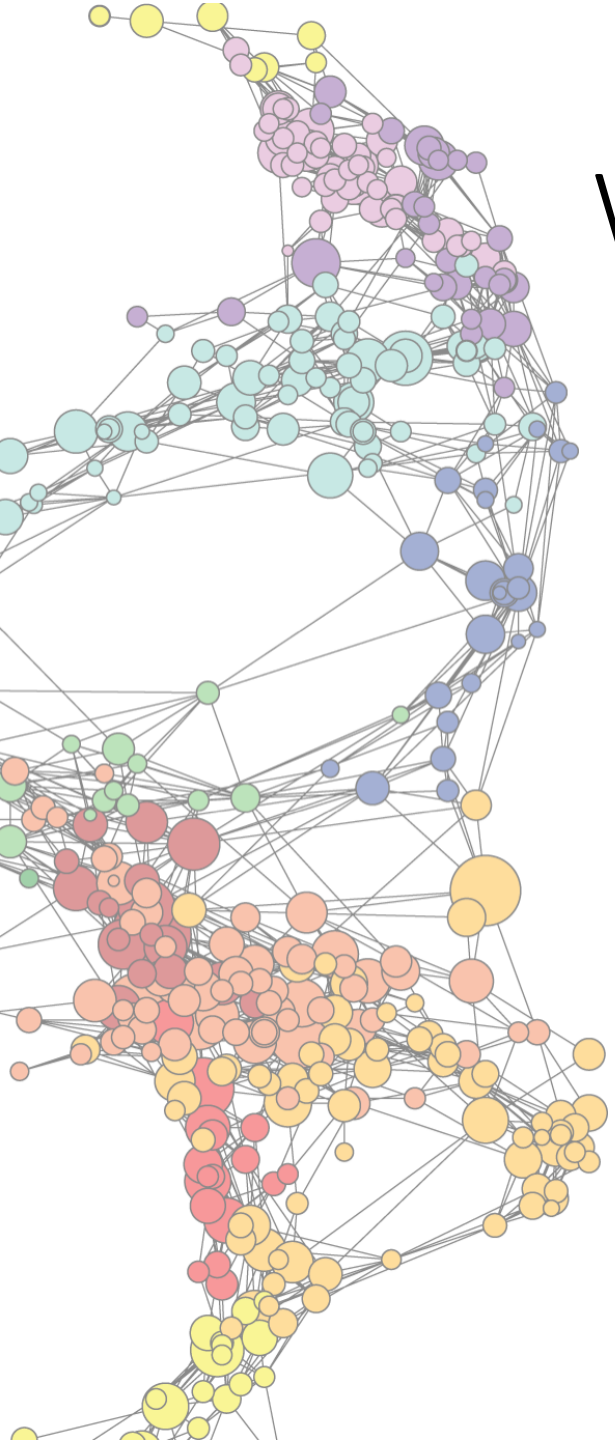
Data and Visualization Services

STA 199L · Spring 2018

Slides: http://bit.ly/STA199LVisSpring2018



# What is data visualization?

**Anything that converts data sources into a visual representation**

*charts, graphs, maps, even just tables*

http://guides.library.duke.edu/datavis

# Why do we visualize?

| 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|
| x | y | x | y | x | y | x | y |
| 10.0 | 8.04 | 10.0 | 9.14 | 10.0 | 7.46 | 8.0 | 6.58 |
| 8.0 | 6.95 | 8.0 | 8.14 | 8.0 | 6.77 | 8.0 | 5.76 |
| 13.0 | 7.58 | 13.0 | 8.74 | 13.0 | 12.74 | 8.0 | 7.71 |
| 9.0 | 8.81 | 9.0 | 8.77 | 9.0 | 7.11 | 8.0 | 8.84 |
| 11.0 | 8.33 | 11.0 | 9.26 | 11.0 | 7.81 | 8.0 | 8.47 |
| 14.0 | 9.96 | 14.0 | 8.10 | 14.0 | 8.84 | 8.0 | 7.04 |
| 6.0 | 7.24 | 6.0 | 6.13 | 6.0 | 6.08 | 8.0 | 5.25 |
| 4.0 | 4.26 | 4.0 | 3.10 | 4.0 | 5.39 | 19.0 | 12.50 |
| 12.0 | 10.84 | 12.0 | 9.13 | 12.0 | 8.15 | 8.0 | 5.56 |
| 7.0 | 4.82 | 7.0 | 7.26 | 7.0 | 6.42 | 8.0 | 7.91 |
| 5.0 | 5.68 | 5.0 | 4.74 | 5.0 | 5.73 | 8.0 | 6.89 |

***Almost identical summary statistics:***

x & y mean

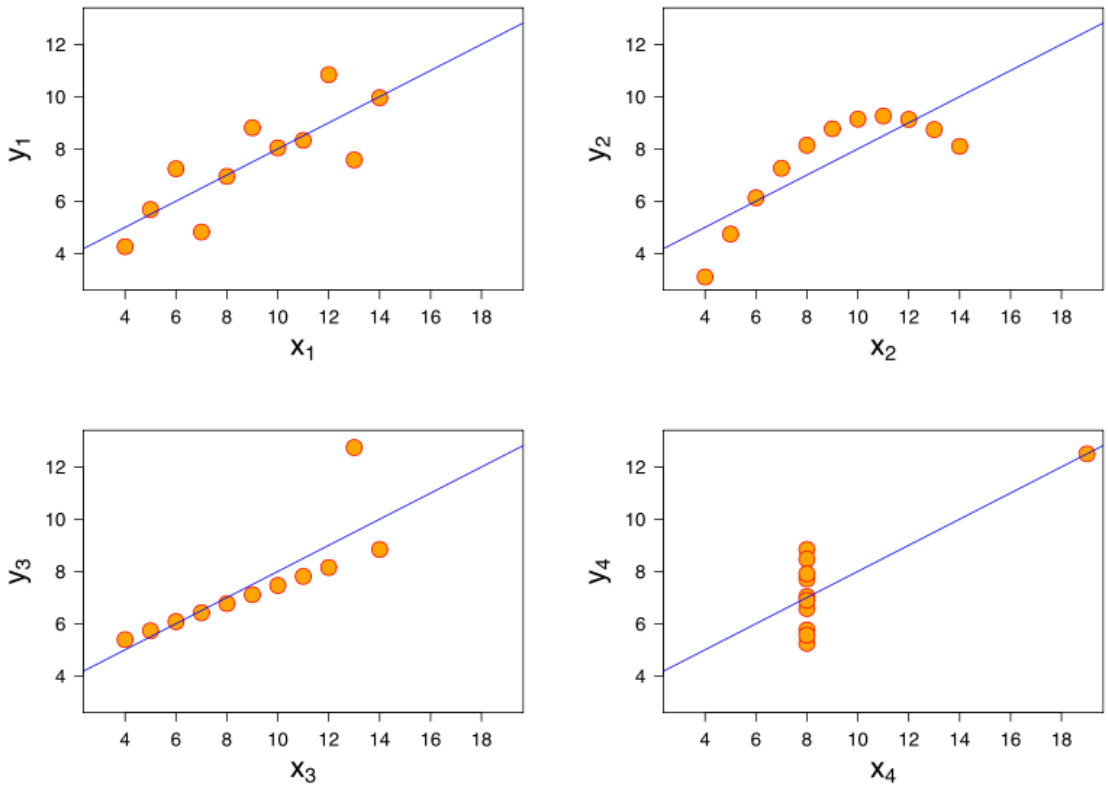
x & y variance

x-y correlation

x-y linear regression

https://en.wikipedia.org/wiki/Anscombe%27s_quartet

# We visualize to see patterns

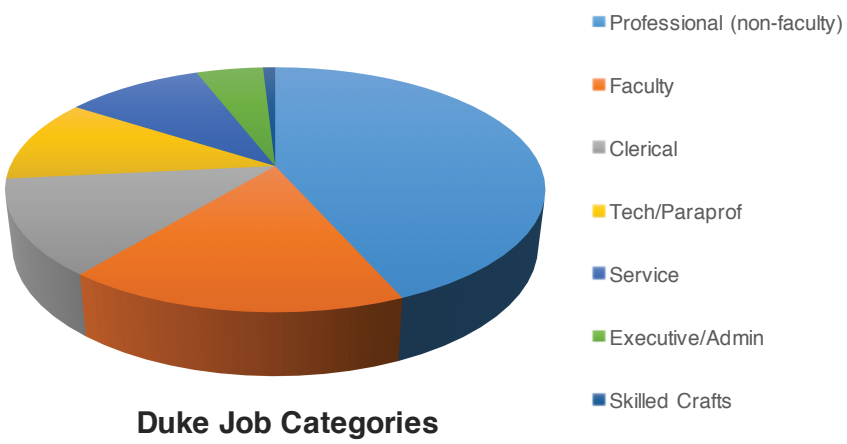


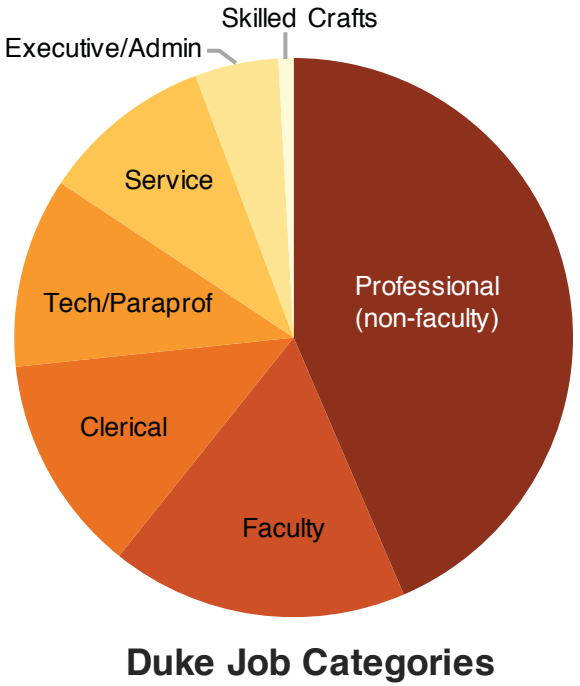

**Anscombe's Quartet**

*http://en.wikipedia.org/wiki/Anscombe%27s_quartet*

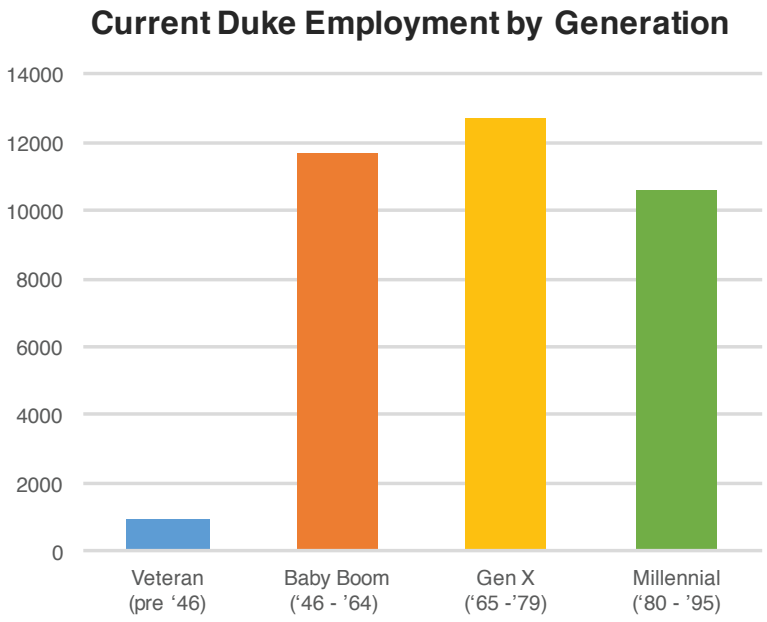
# Designing effective visualizations

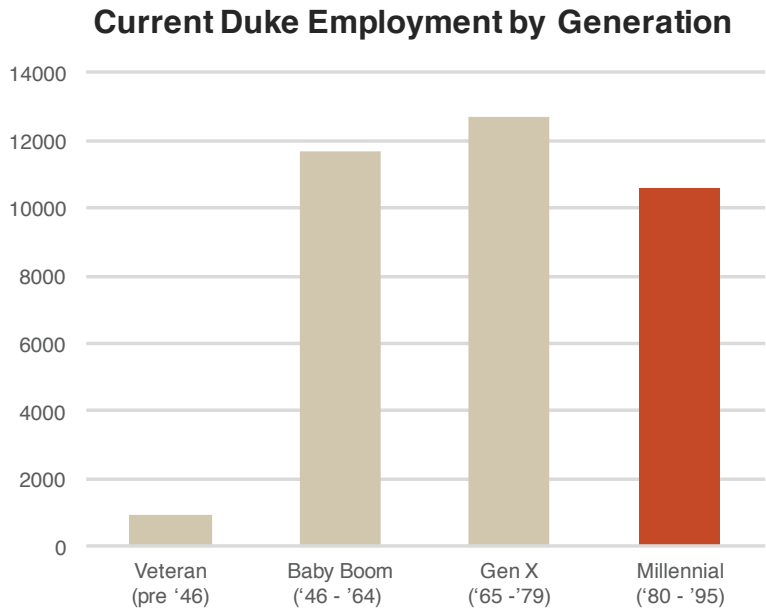
# Keep it simple



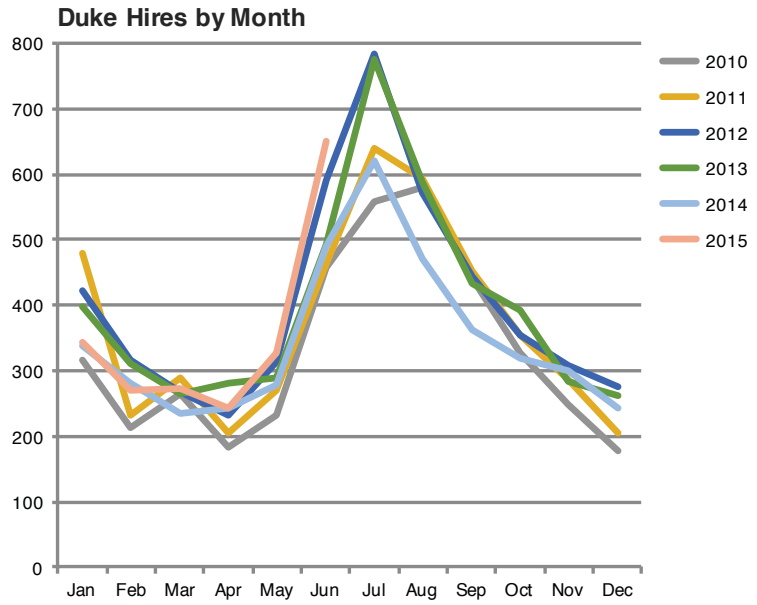



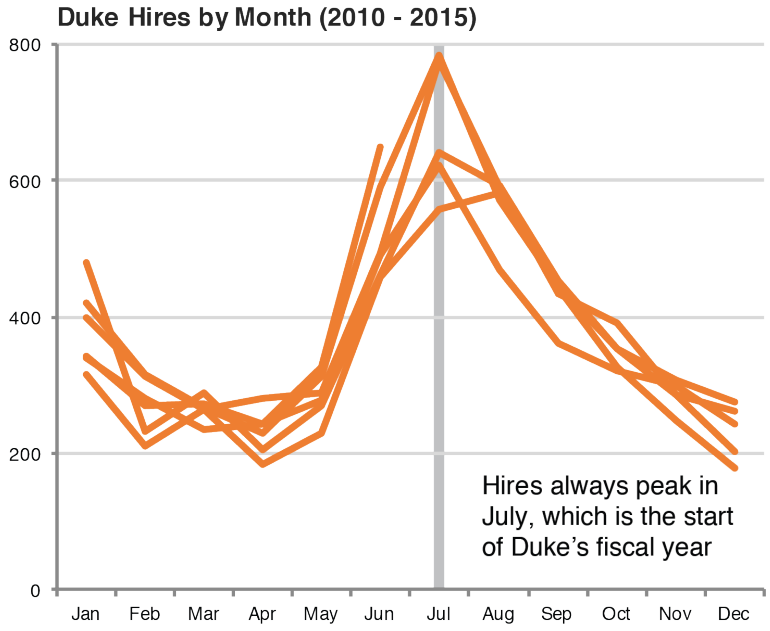
# Use color to draw attention

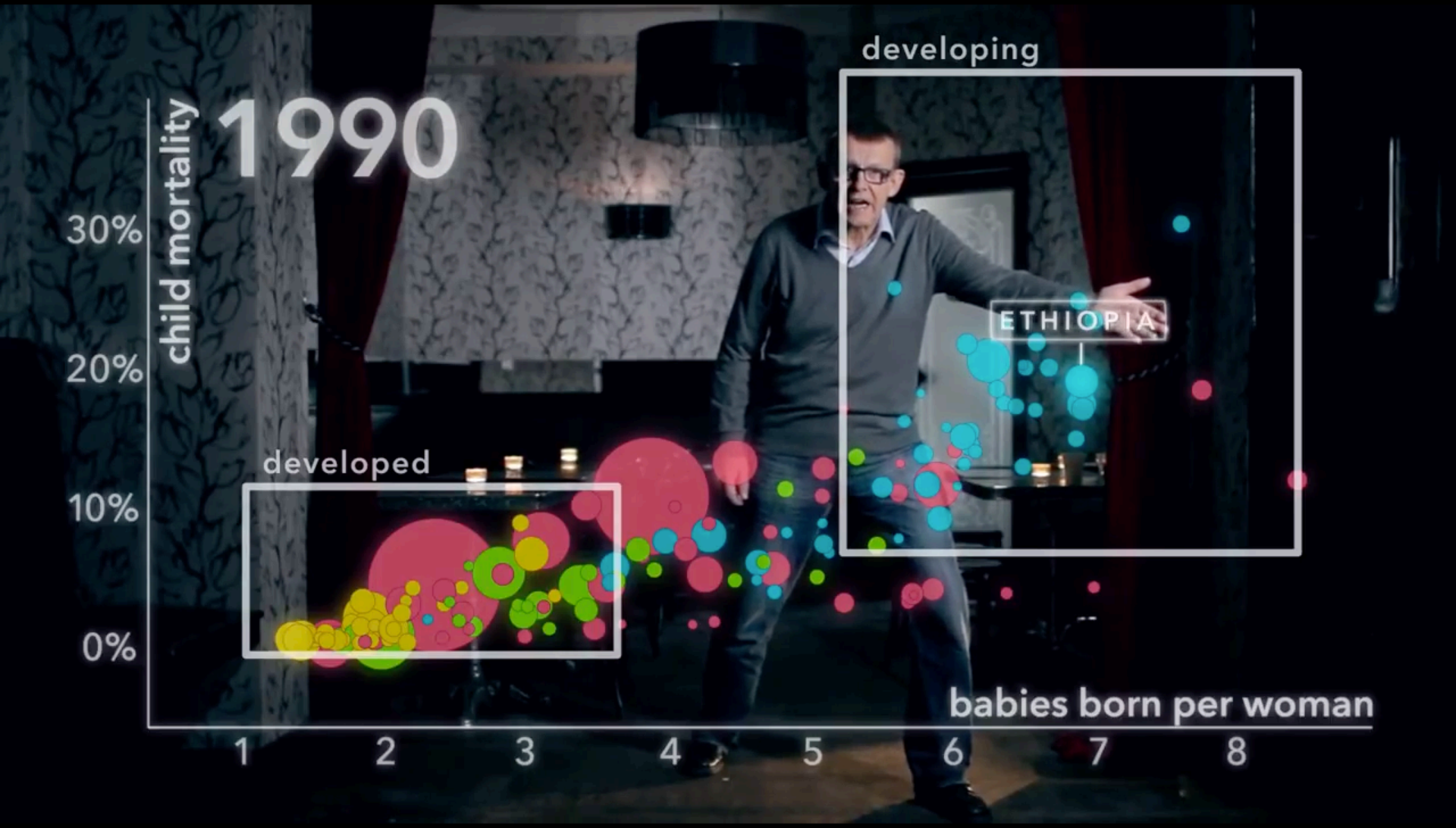


# Tell a story


Duke Hires by Month
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2010
2011
2012
2013
2014
2015

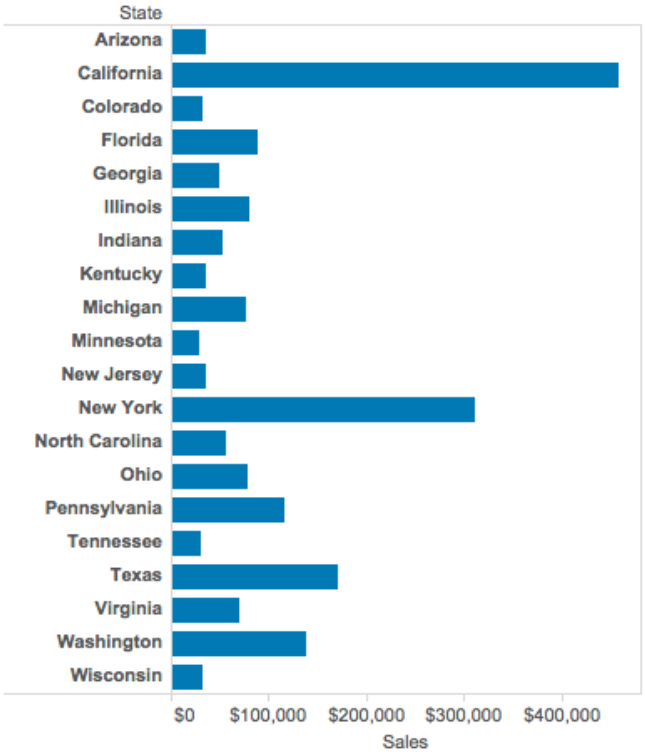

Duke Hires by Month (2010 - 2015)
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Hires always peak in July, which is the start of Duke's fiscal year



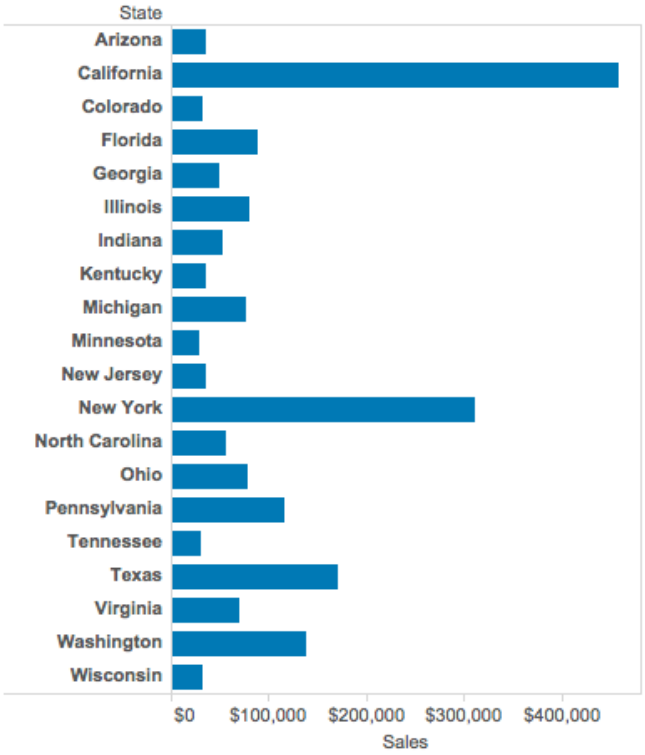

http://www.youtube.com/watch?v=OwII-dwh-bk

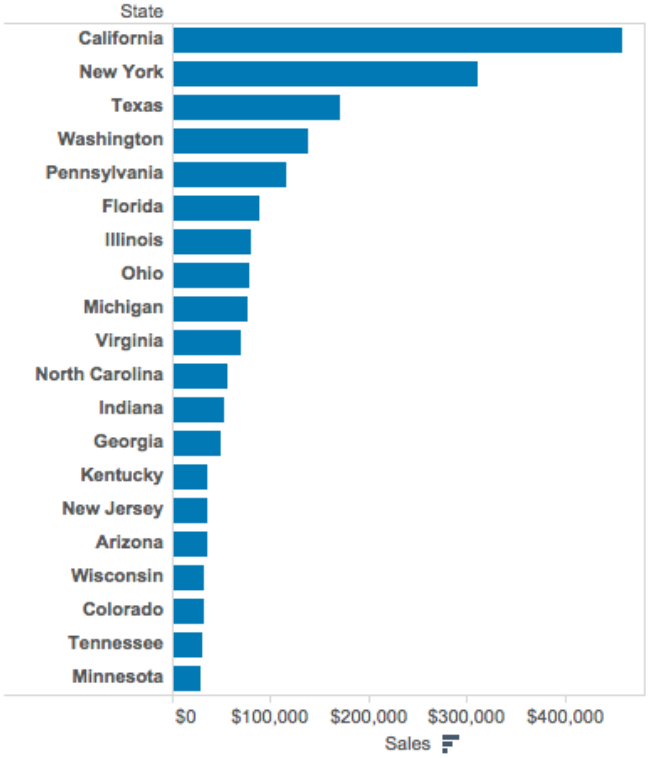
# Common missteps

# Default ordering hides patterns

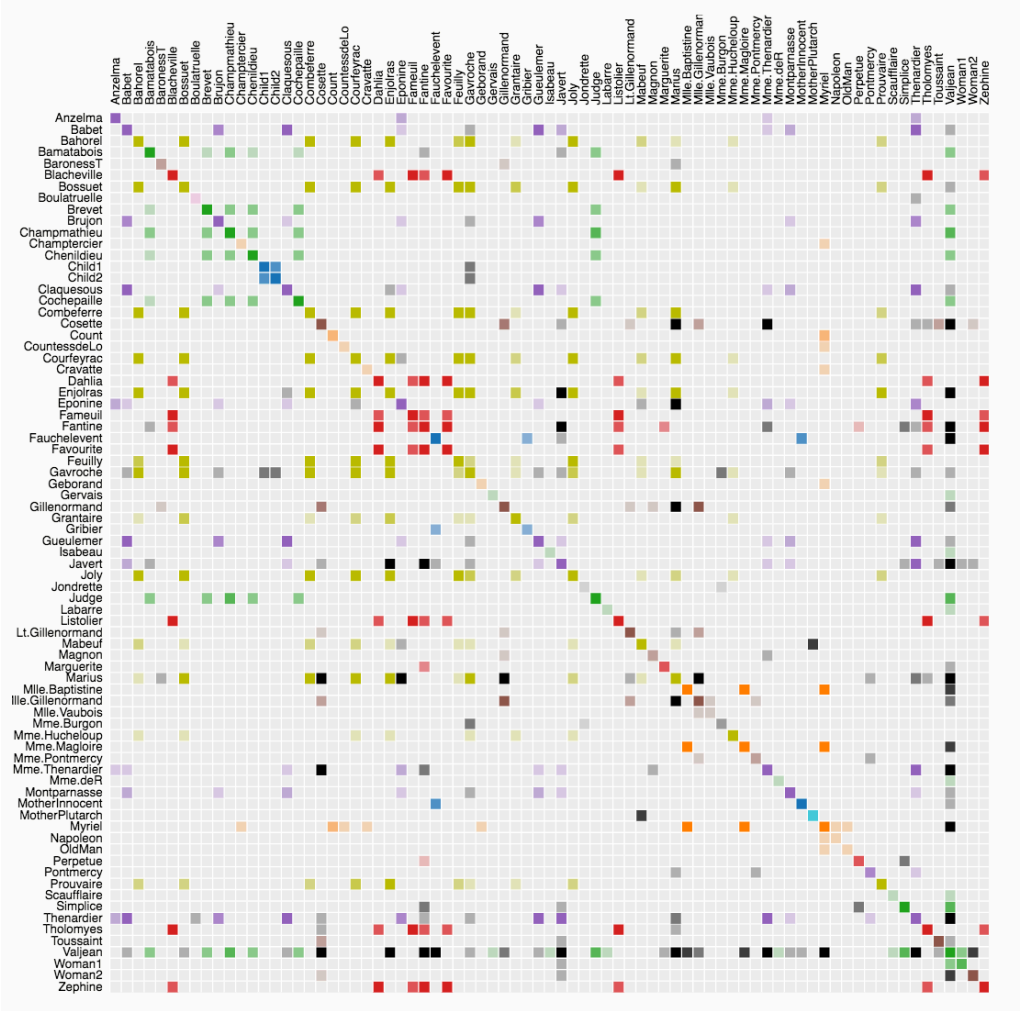


# Sorting reveals patterns



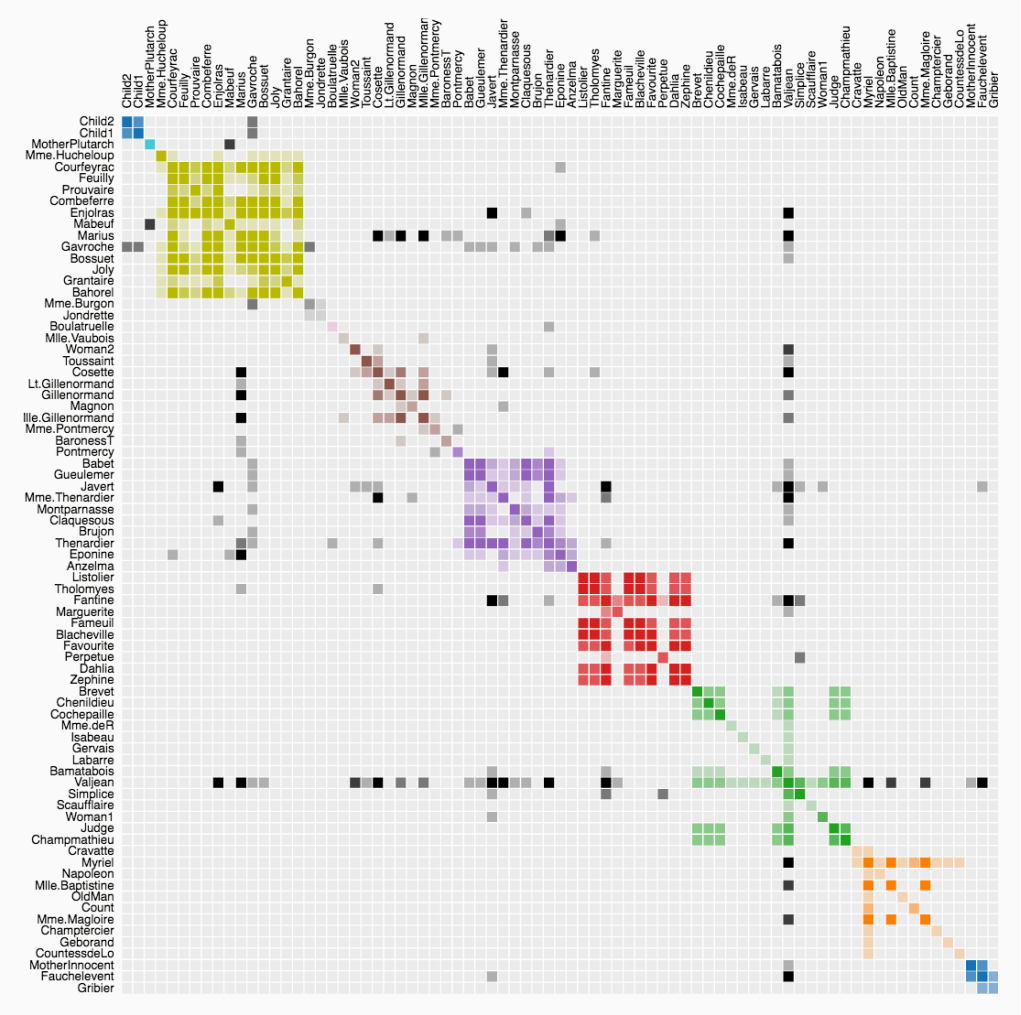



# Default ordering hides patterns




https://bost.ocks.org/mike/miserables/

# Cluster ordering reveals patterns




https://bost.ocks.org/mike/miserables/

| Trust rank | Index rank | Borough | Amount approved (£) | Number of grants |
|---|---|---|---|---|
| 1 | 3 | Tower Hamlets | £9,692,642 | 269 |
| 2 | 2 | Hackney | £7,809,608 | 225 |
| 3 | 12 | Southwark | £7,266,118 | 232 |
| 4 | 14 | Camden | £6,140,419 | 136 |
| 5 | 4 | Islington | £5,424,137 | 156 |
| 6 | 8 | Lambeth | £5,257,941 | 156 |
| 7 | 2 | Newham | £5,217,075 | 154 |
| 8 | 13 | Hammersmith and Fulham | £4,085,708 | 109 |
| 9 | 29 | Merton | £3,656,112 | 113 |
| 10 | 20 | Croydon | £3,629,066 | 127 |
| 11 | 9 | Lewisham | £3,537,049 | 144 |
| 12 | 17 | Westminster | £3,357,911 | 100 |
| 13 | 15 | Ealing | £3,057,709 | 84 |
| 14 | 30 | Bromley | £3,038,621 | 131 |
| 15 | 19 | Kensington and Chelsea | £2,979,468 | 74 |
| 16 | 11 | Brent | £2,898,224 | 85 |
| 17 | 10 | Greenwich | £2,837,658 | 87 |
| 18 | 24 | Barnet | £2,796,587 | 99 |
| 19 | 21 | Wandsworth | £2,592,453 | 89 |
| 20 | 5 | Waltham Forest | £2,505,730 | 131 |
| 21 | 28 | Sutton | £2,468,511 | 87 |
| 22 | 18 | Hounslow | £2,383,393 | 75 |
| 23 | 7 | Haringey | £2,360,290 | 101 |
| 24 | 22 | Redbridge | £2,285,173 | 75 |
| 25 | 33 | Rechmond upon Thames | £2,249,983 | 133 |
| 26 | 23 | Hullingdon | £2,181,566 | 103 |
| 27 | 16 | Enfield | £2,145,800 | 86 |
| 28 | 6 | Barking and Dagenham | £1,943,597 | 68 |
| 29 | 25 | Havering | £1,934,424 | 95 |
| 30 | 26 | Bexley | £1,631,415 | 103 |
| 31 | 27 | Harrow | £1,516,193 | 62 |
| 32 | 31 | Kingston upon Thames | £1,353,125 | 55 |
| 33 | 32 | City of London | £402,060 | 11 |
| | | | | |
| | | Several Additional Inner Bouroughs | £18,704,677 | 481 |
| | | Several Additional Outer Boroughs | £6,392,100 | 164 |
| | | Other | £28,566,830 | 566 |
| | | London-wide | £86,583,750 | 1214 |
| | | | | |
| | | Total | £252,883,123 | 6180 |

# Tables easily hide patterns

Total grants spend by London Borough

September 1995 to March 2011

http://www.storytellingwithdata.com/blog/2012/02/grables-and-taphs

## Total grant spend by London Borough

September 1995 - March 2011

| Borough | Trust rank | Index rank | Number of grants | Amount approved (£) |
|---|---|---|---|---|
| Tower Hamlets | 1 | 3 | 269 | 9,692,642 |
| Hackney | 2 | 2 | 225 | 7,809,608 |
| Southwark | 3 | 12 | 232 | 7,266,118 |
| Camden | 4 | 14 | 136 | 6,140,419 |
| Islington | 5 | 4 | 156 | 5,424,137 |
| Lambeth | 6 | 8 | 156 | 5,257,941 |
| Newham | 7 | 2 | 154 | 5,217,075 |
| Hammersmith and Fulham | 8 | 13 | 109 | 4,085,708 |
| Merton | 9 | 29 | 113 | 3,656,112 |
| Croydon | 10 | 20 | 127 | 3,629,066 |
| Lewisham | 11 | 9 | 144 | 3,537,049 |
| Westminster | 12 | 17 | 100 | 3,357,911 |
| Ealing | 13 | 15 | 84 | 3,057,709 |
| Bromley | 14 | 30 | 131 | 3,038,621 |
| Kensington and Chelsea | 15 | 19 | 74 | 2,979,468 |
| Brent | 16 | 11 | 85 | 2,898,224 |
| Greenwich | 17 | 10 | 87 | 2,837,658 |
| Barnet | 18 | 24 | 99 | 2,796,587 |
| Wandsworth | 19 | 21 | 89 | 2,592,453 |
| Waltham Forest | 20 | 5 | 131 | 2,505,730 |
| Sutton | 21 | 28 | 87 | 2,468,511 |
| Hounslow | 22 | 18 | 75 | 2,383,393 |
| Haringey | 23 | 7 | 101 | 2,360,290 |
| Redbridge | 24 | 22 | 75 | 2,285,173 |
| Rechmond upon Thames | 25 | 33 | 133 | 2,249,983 |
| Hullingdon | 26 | 23 | 103 | 2,181,566 |
| Enfield | 27 | 16 | 86 | 2,145,800 |
| Barking and Dagenham | 28 | 6 | 68 | 1,943,597 |
| Havering | 29 | 25 | 95 | 1,934,424 |
| Bexley | 30 | 26 | 103 | 1,631,415 |
| Harrow | 31 | 27 | 62 | 1,516,193 |
| Kingston upon Thames | 32 | 31 | 55 | 1,353,125 |
| City of London | 33 | 32 | 11 | 402,060 |
| Several Additional Inner Bouroughs | | | 481 | 18,704,677 |
| Several Additional Outer Boroughs | | | 164 | 6,392,100 |
| Other | | | 566 | 28,566,830 |
| London-wide | | | 1,214 | 86,583,750 |
| **Total** | | | **6,180** | **252,883,123** |

# Help people see patterns in tables

http://www.storytellingwithdata.com/blog/2012/02/grables-and-taphs

# Help viewers interpret tables

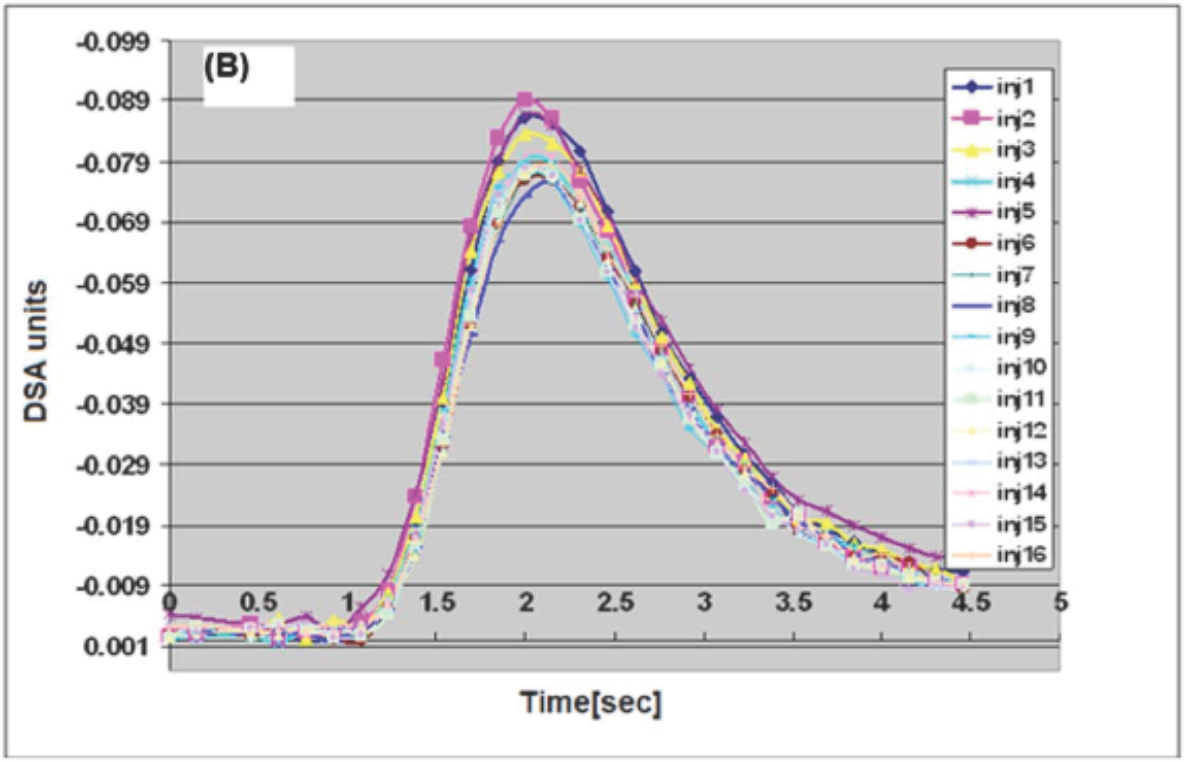
- Limit and standardize decimal places
- Emphasize important values with color, bold text and annotations
- Sort rows by values
- Turn table into another chart or a handout

**MDG 4 Progress 1990-2013: Low Income Countries**

| Country | 1990 (Per 1,000) | 2013 (per 1,000) | Percent Change | 2015 Target | Percent of Target Met |
|---|---|---|---|---|---|
| Afghanistan | 179 | 97 | 46% | 60.9 | 69% |
| Bangladesh | 144 | 41 | 72% | 49 | 108% |
| Benin | 179 | 85 | 53% | 60.9 | 80% |
| Burkina Faso | 202 | 98 | 51% | 68.7 | 78% |
| Burundi | 171 | 83 | 51% | 58.1 | 78% |
| Cambodia | 118 | 38 | 68% | 40.1 | 103% |
| Central African Republic | 177 | 139 | 21% | 60.2 | 33% |
| Chad | 215 | 148 | 31% | 73.1 | 47% |
| Comoros | 125 | 78 | 38% | 42.5 | 57% |
| Congo, Democratic Republic of | 176 | 119 | 32% | 59.8 | 49% |
| Eritrea | 151 | 50 | 67% | 51.3 | 101% |
| Ethiopia | 205 | 64 | 69% | 69.7 | 104% |
| Gambia, The | 170 | 74 | 56% | 57.8 | 86% |
| Guinea | 238 | 101 | 58% | 80.9 | 87% |
| Guinea-Bissau | 225 | 124 | 45% | 76.5 | 68% |
| Haiti | 145 | 73 | 50% | 49.3 | 75% |
| Kenya | 99 | 71 | 28% | 33.7 | 43% |
| Korea, DPR | 43 | 27 | 37% | 14.6 | 56% |
| Liberia | 248 | 71 | 71% | 84.3 | 108% |
| Madagascar | 161 | 56 | 65% | 54.7 | 99% |
| Malawi | 245 | 68 | 72% | 83.3 | 109% |
| Mali | 254 | 123 | 52% | 86.4 | 78% |
| Mozambique | 237 | 87 | 63% | 80.6 | 96% |
| Myanmar | 109 | 51 | 53% | 37.1 | 81% |
| Nepal | 142 | 40 | 72% | 48.3 | 109% |
| Niger | 327 | 104 | 68% | 111.2 | 103% |
| Rwanda | 152 | 52 | 66% | 51.7 | 99.70% |
| Sierra Leone | 268 | 161 | 40% | 91.1 | 60% |
| Somalia | 180 | 146 | 19% | 61.2 | 29% |
| Tajikistan | 108 | 48 | 56% | 39.8 | 84% |
| Tanzania | 167 | 52 | 69% | 56.8 | 104% |
| Togo | 146 | 85 | 42% | 49.6 | 63% |
| Uganda | 179 | 66 | 63% | 60.9 | 96% |
| Zimbabwe | 75 | 89 | -19% | 25.5 | -28% |

https://dpt.duhs.duke.edu/files/Group%2011.pdf

# Leave out non-story details



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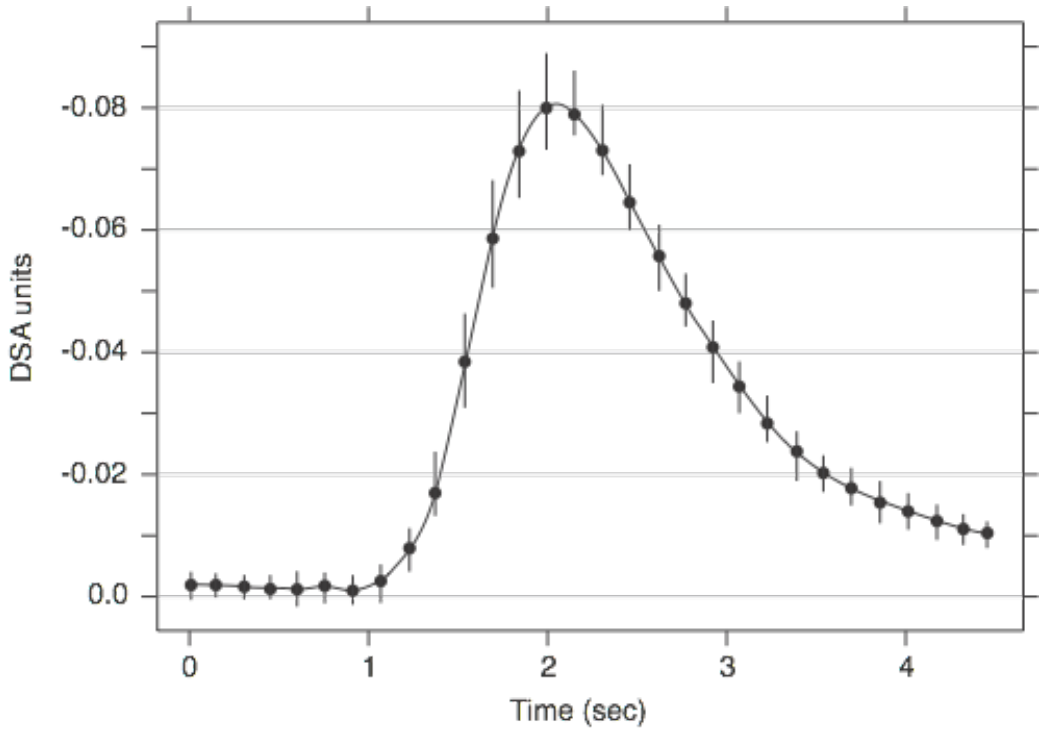
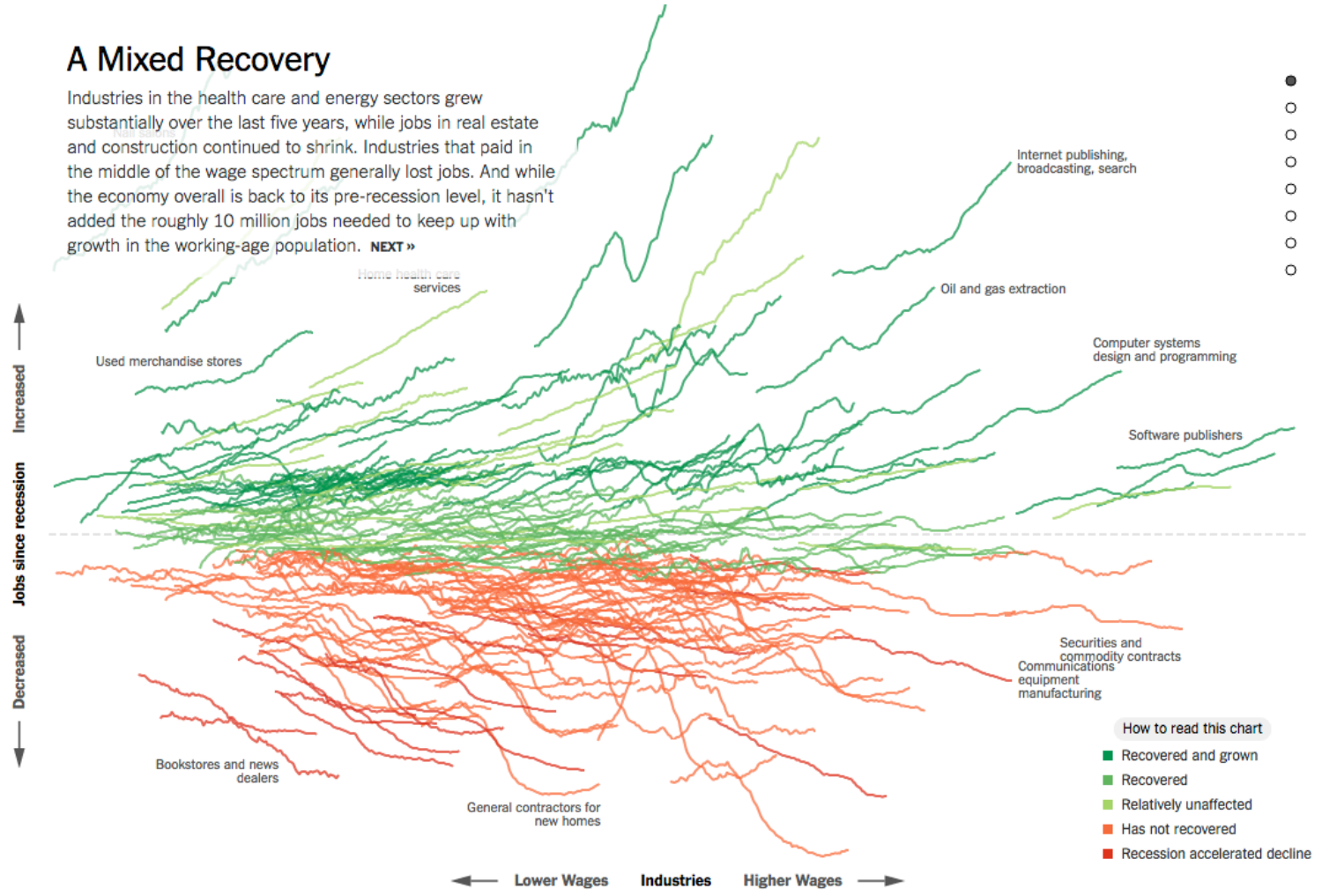


# All the data doesn't tell a story




http://www.nytimes.com/interactive/2014/06/05/upshot/how-the-recession-reshaped-the-economy-in-255-charts.html

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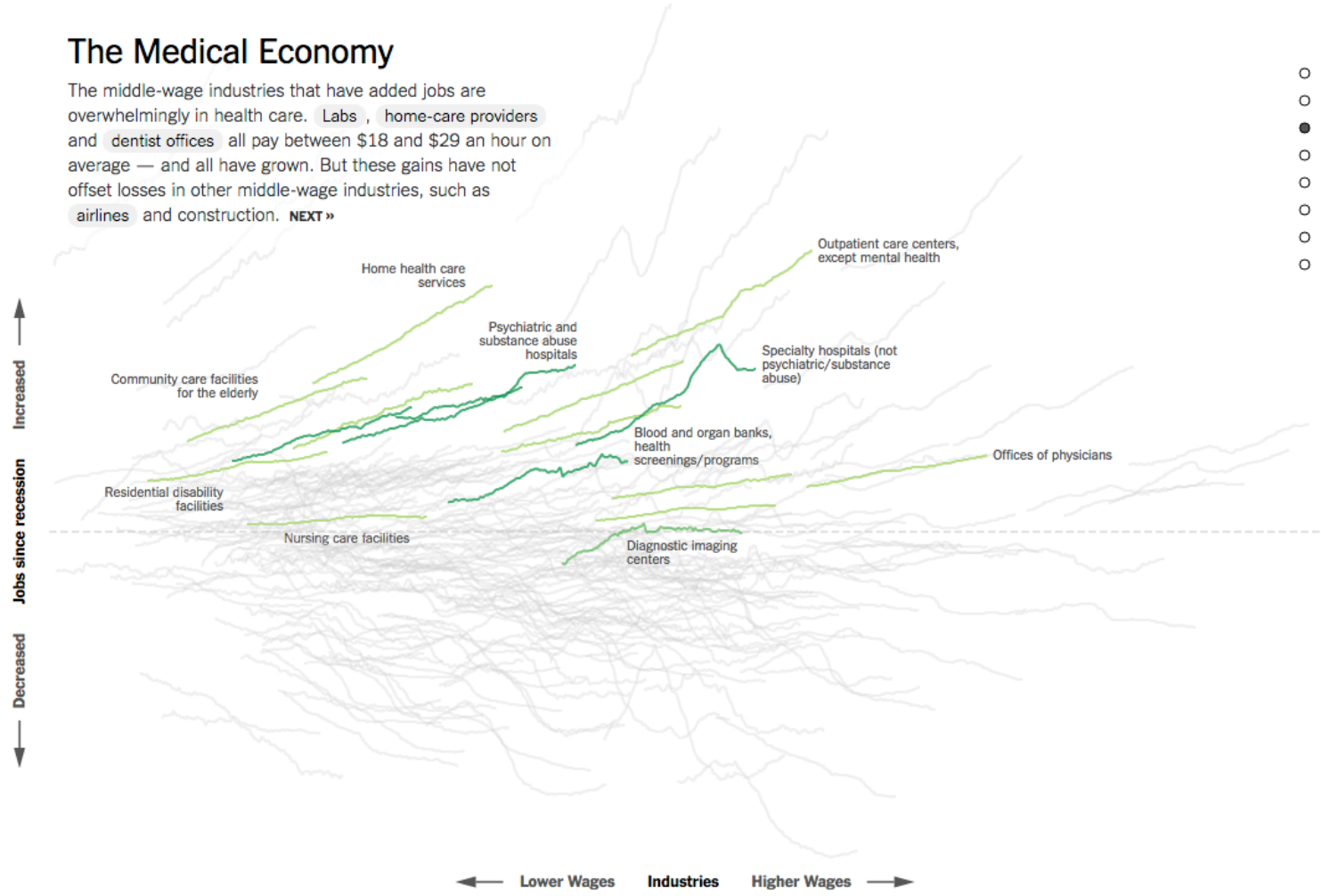


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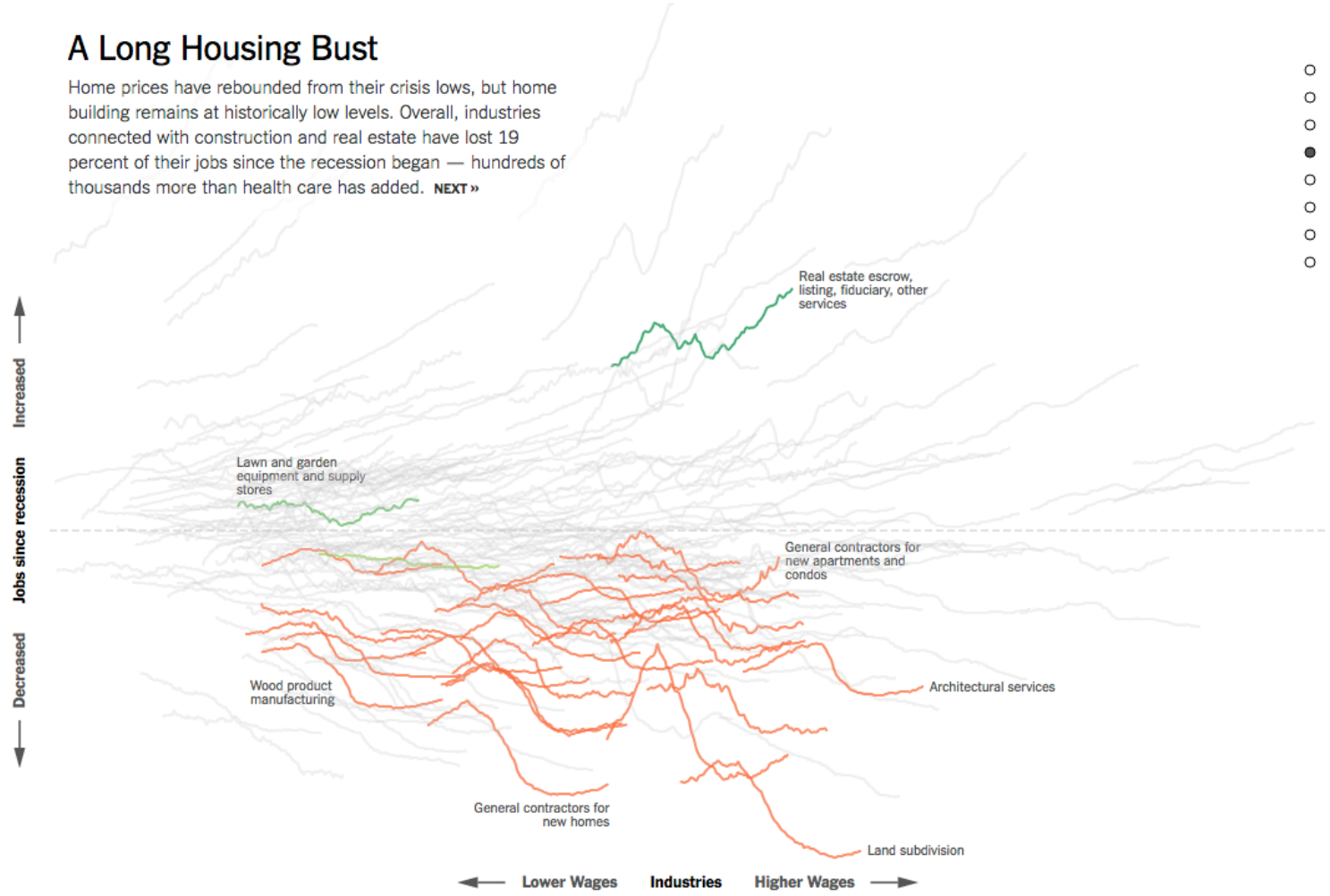
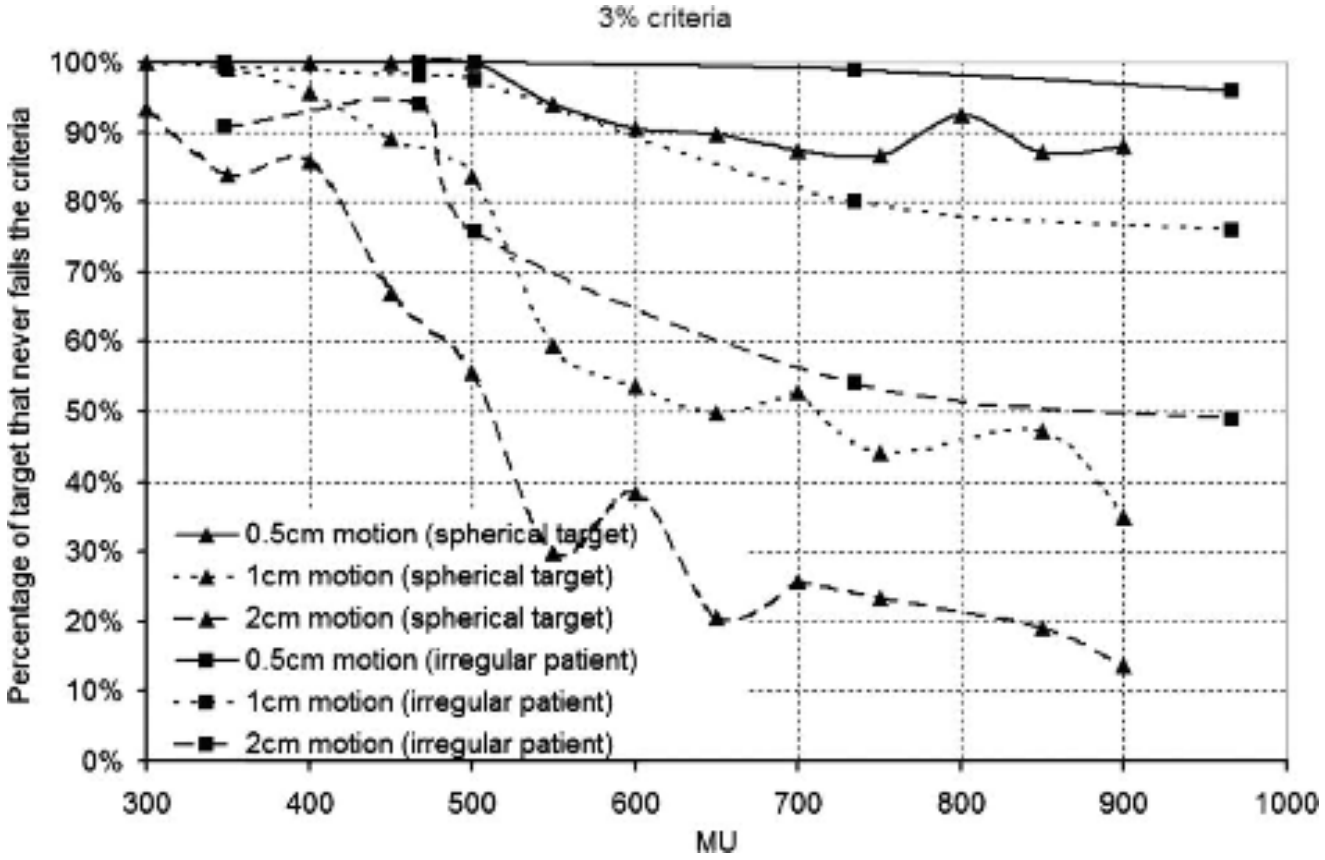
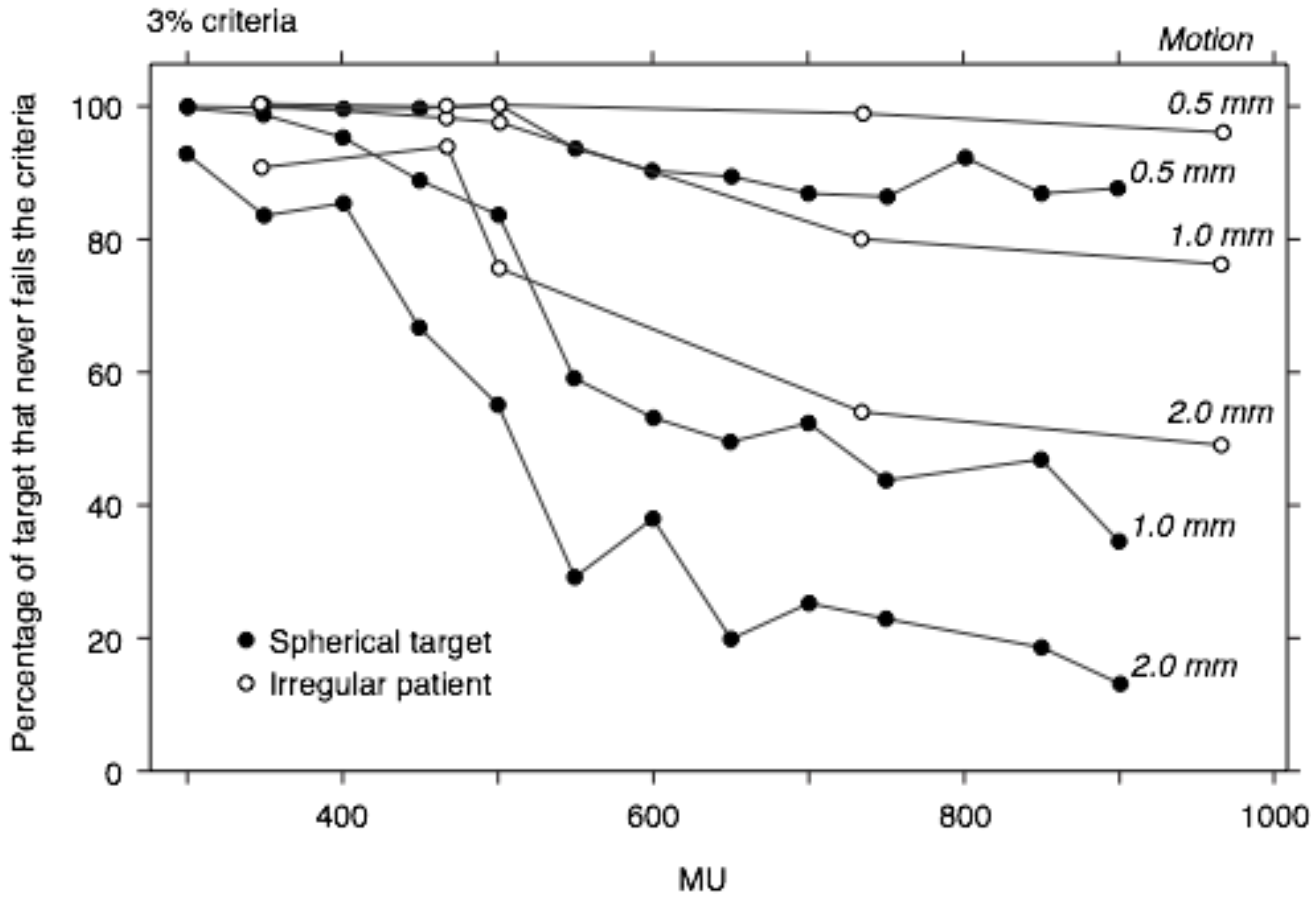



http://www.nytimes.com/interactive/2014/06/05/upshot/how-the-recession-reshaped-the-economy-in-255-charts.html

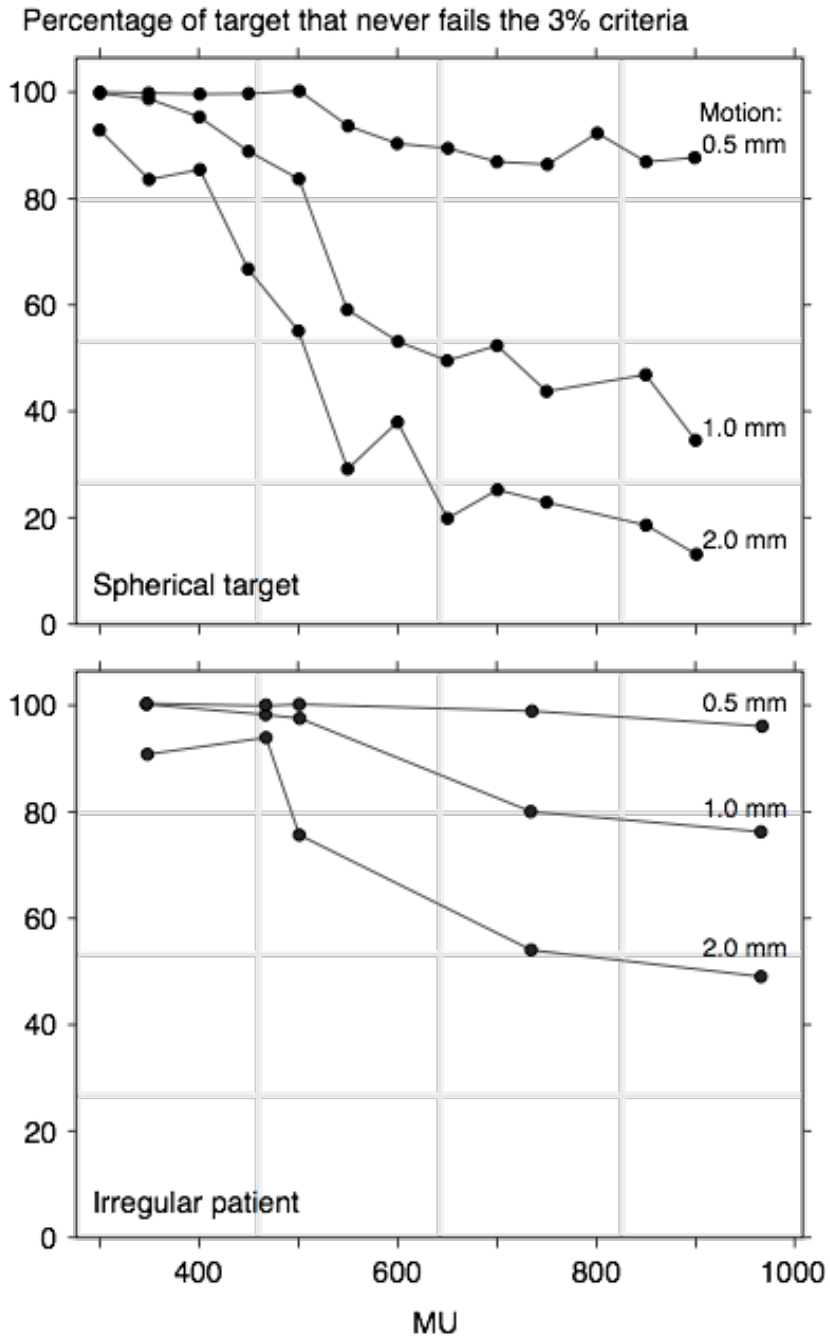
# Original


3% criteria
Percentage of target that never fails the criteria
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
300
400
500
600
700
800
900
1000
MU
0.5cm motion (spherical target)
1cm motion (spherical target)
2cm motion (spherical target)
0.5cm motion (irregular patient)
1cm motion (irregular patient)
2cm motion (irregular patient)

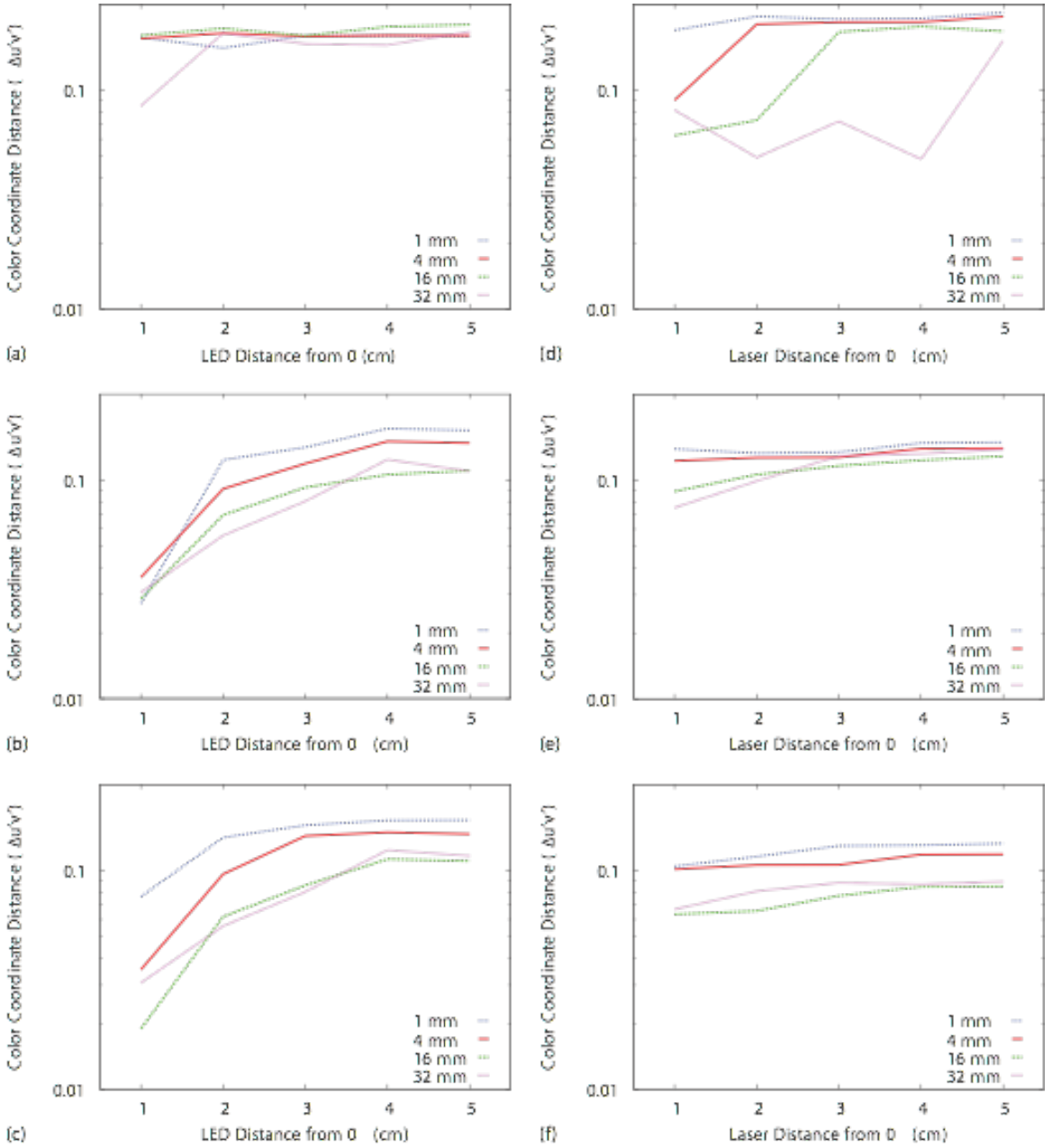
# Reworked as single plot



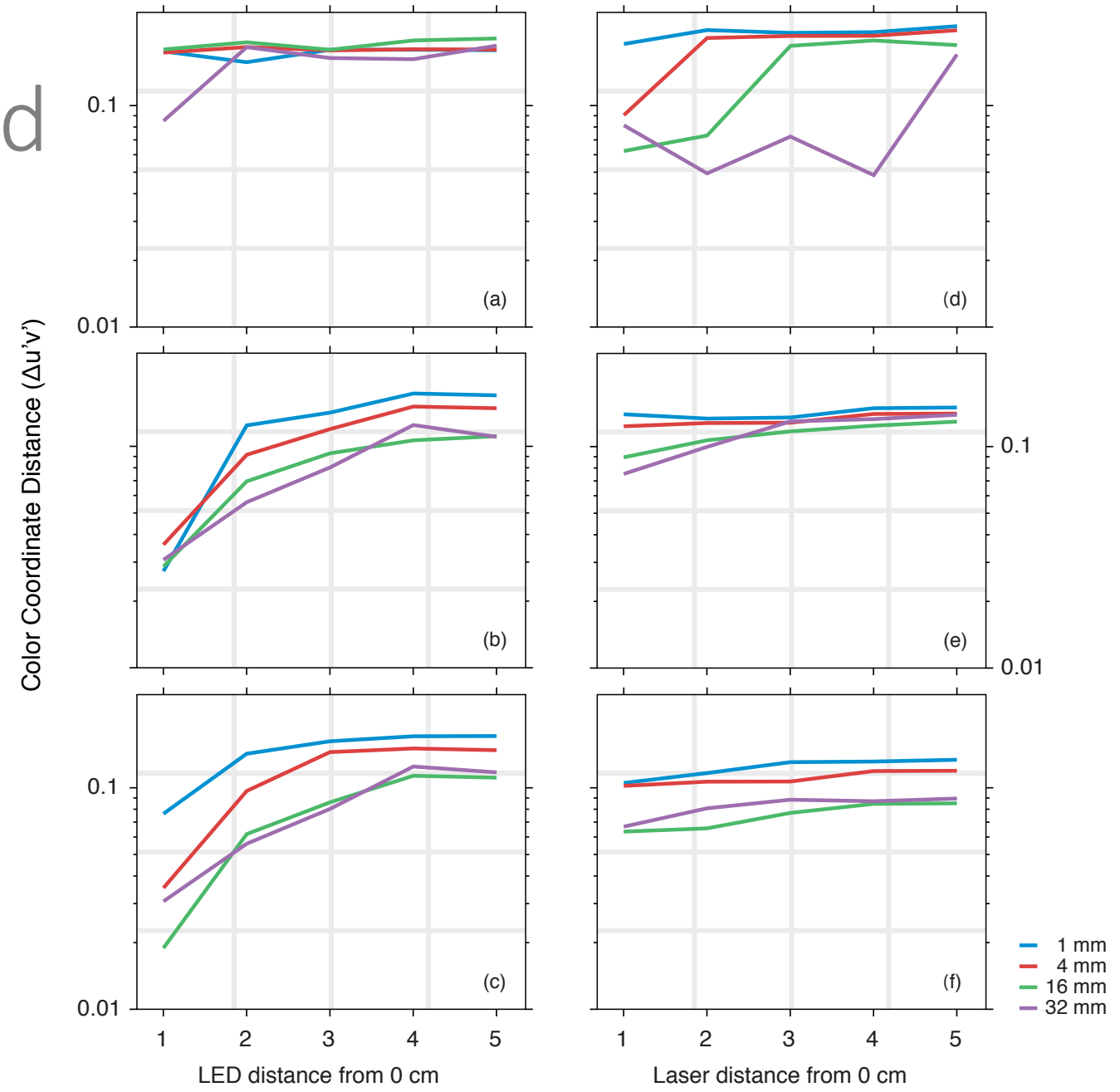
# Reworked as small multiples



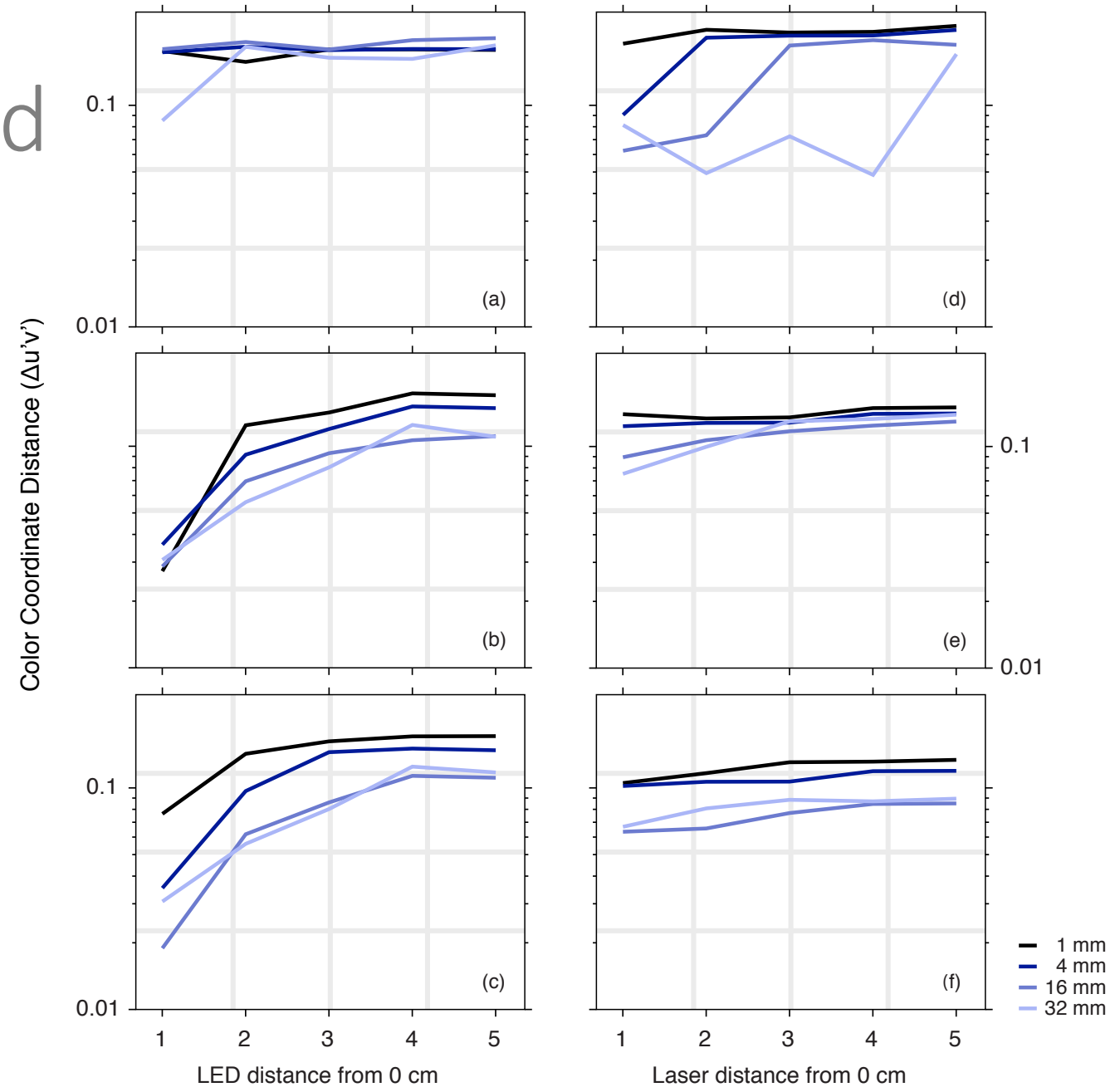
# Original

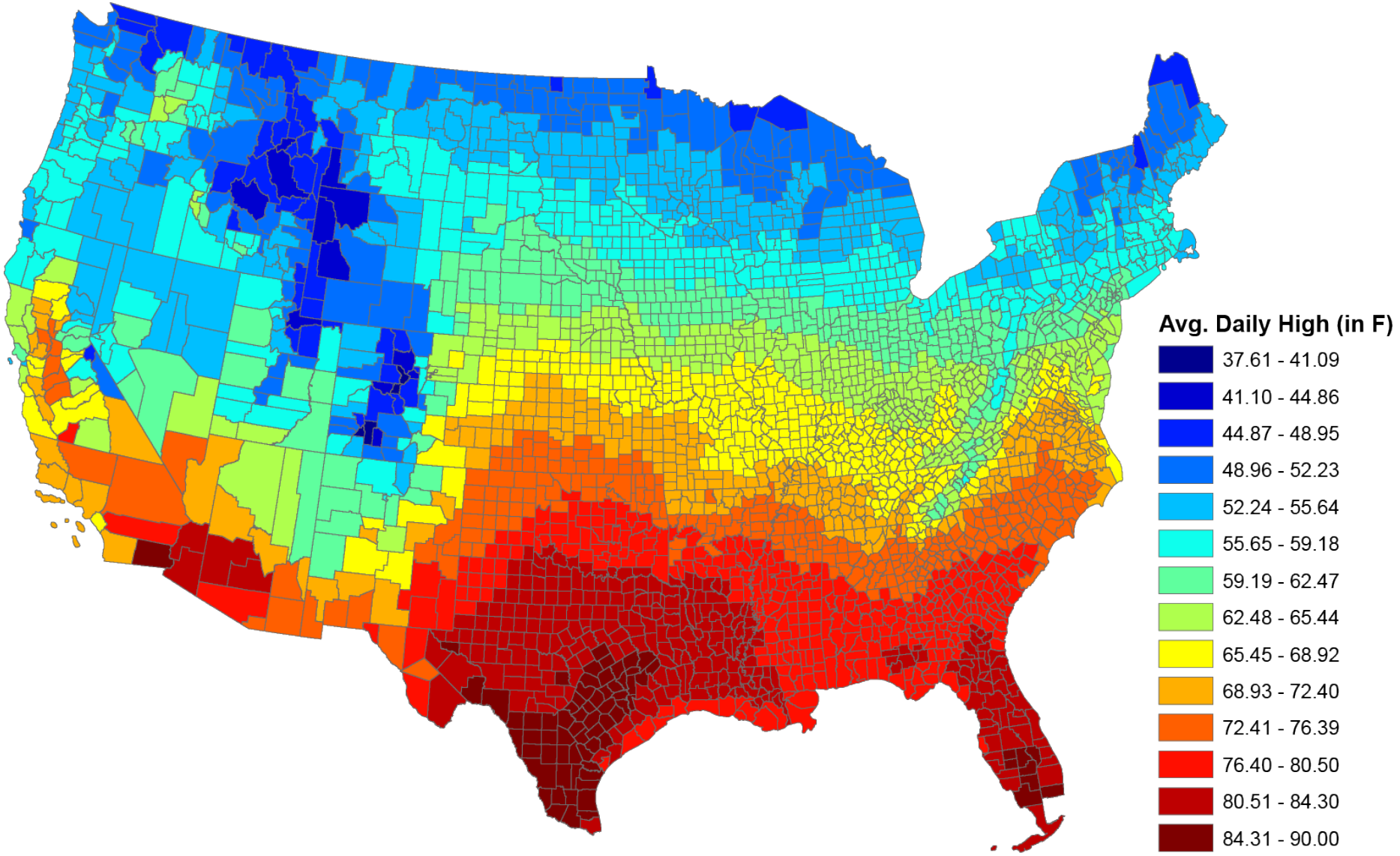

Color Coordinate Distance ( Δu'v' )
0.1
0.01
1 mm
4 mm
16 mm
32 mm
1
2
3
4
5
(a)
LED Distance from 0 (cm)
(d)
Laser Distance from 0 (cm)
(b)
LED Distance from 0 (cm)
(e)
Laser Distance from 0 (cm)
(c)
LED Distance from 0 (cm)
(f)
Laser Distance from 0 (cm)

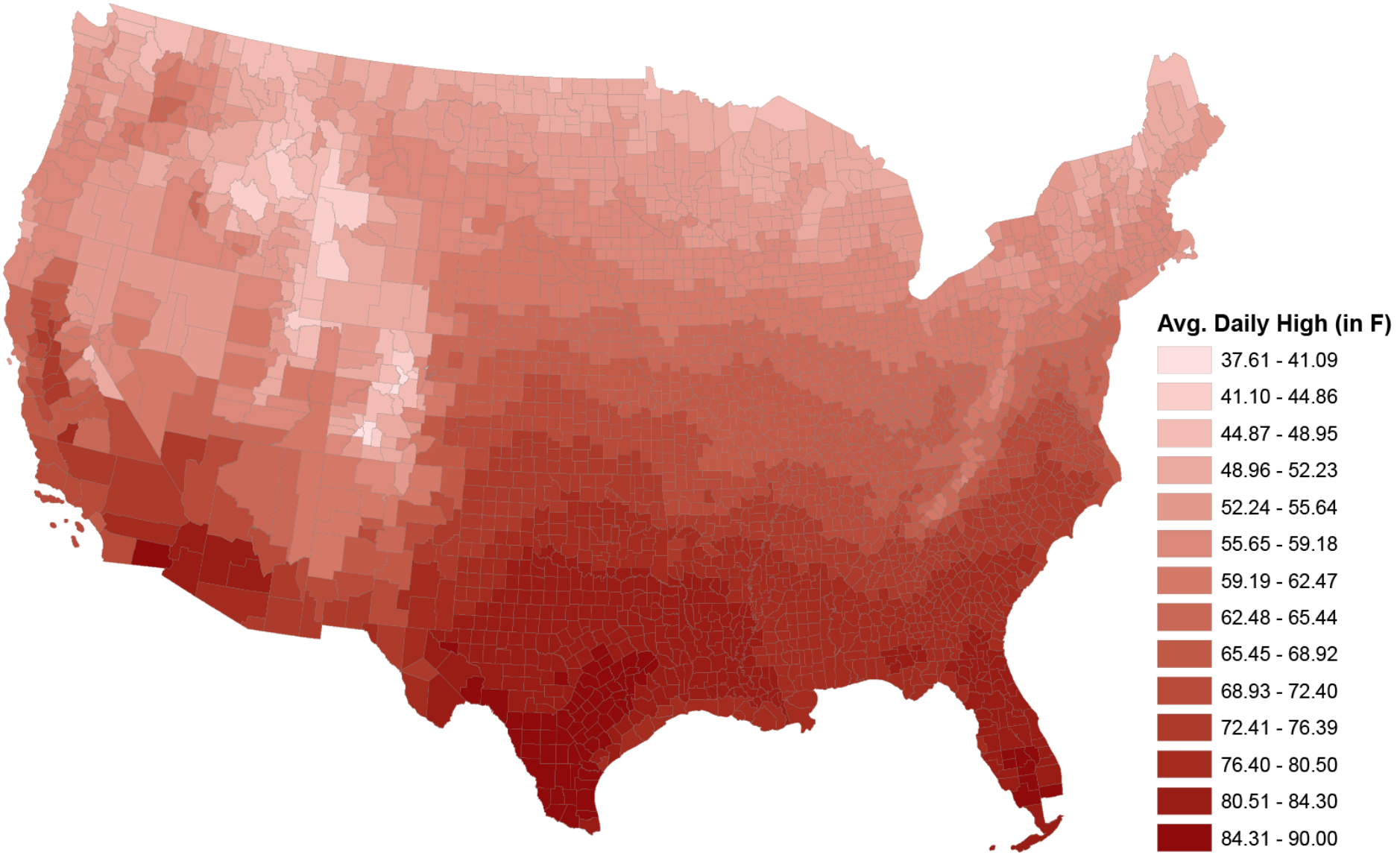
# Reworked


Color Coordinate Distance (Δu'v')
0.1
0.01
(a)
(b)
(c)
(d)
(e)
(f)
1
2
3
4
5
LED distance from 0 cm
Laser distance from 0 cm
1 mm
4 mm
16 mm
32 mm

# Reworked

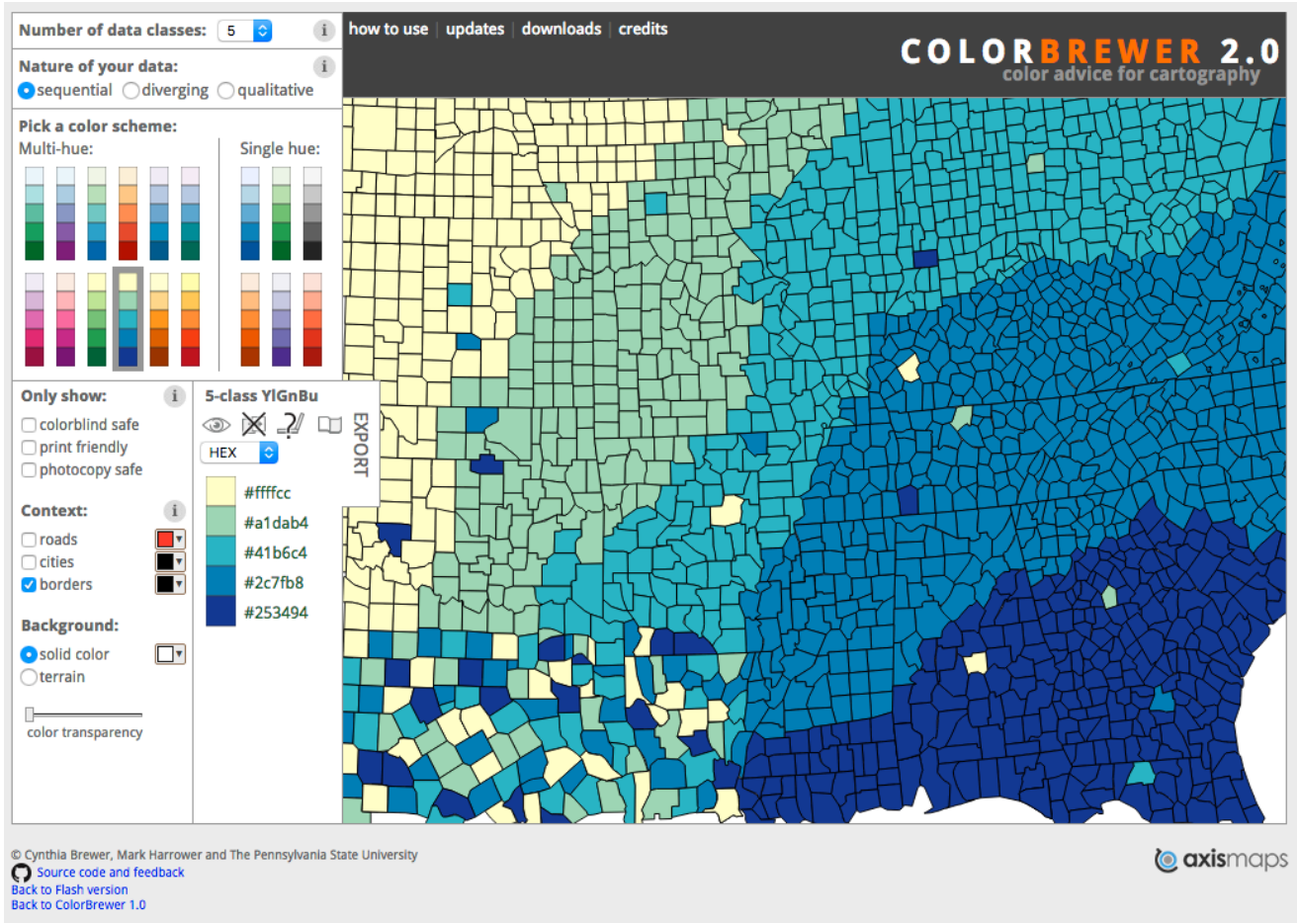

Color Coordinate Distance (Δu'v')
0.1
0.01
(a)
(b)
(c)
(d)
(e)
(f)
1
2
3
4
5
LED distance from 0 cm
Laser distance from 0 cm
1 mm
4 mm
16 mm
32 mm

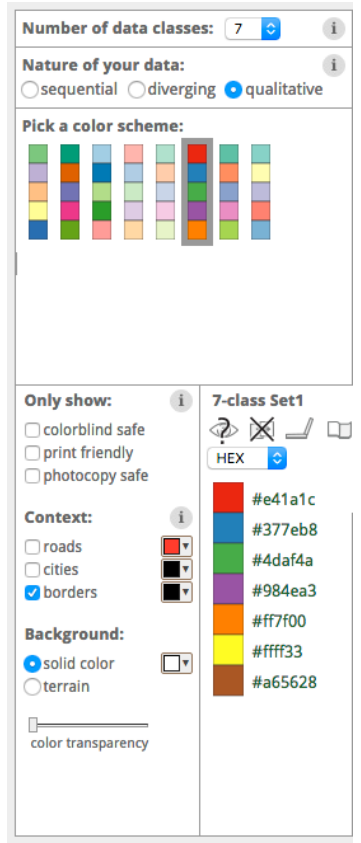

Avg. Daily High (in F)
37.61 - 41.09
41.10 - 44.86
44.87 - 48.95
48.96 - 52.23
52.24 - 55.64
55.65 - 59.18
59.19 - 62.47
62.48 - 65.44
65.45 - 68.92
68.93 - 72.40
72.41 - 76.39
76.40 - 80.50
80.51 - 84.30
84.31 - 90.00


Avg. Daily High (in F)
37.61 - 41.09
41.10 - 44.86
44.87 - 48.95
48.96 - 52.23
52.24 - 55.64
55.65 - 59.18
59.19 - 62.47
62.48 - 65.44
65.45 - 68.92
68.93 - 72.40
72.41 - 76.39
76.40 - 80.50
80.51 - 84.30
84.31 - 90.00

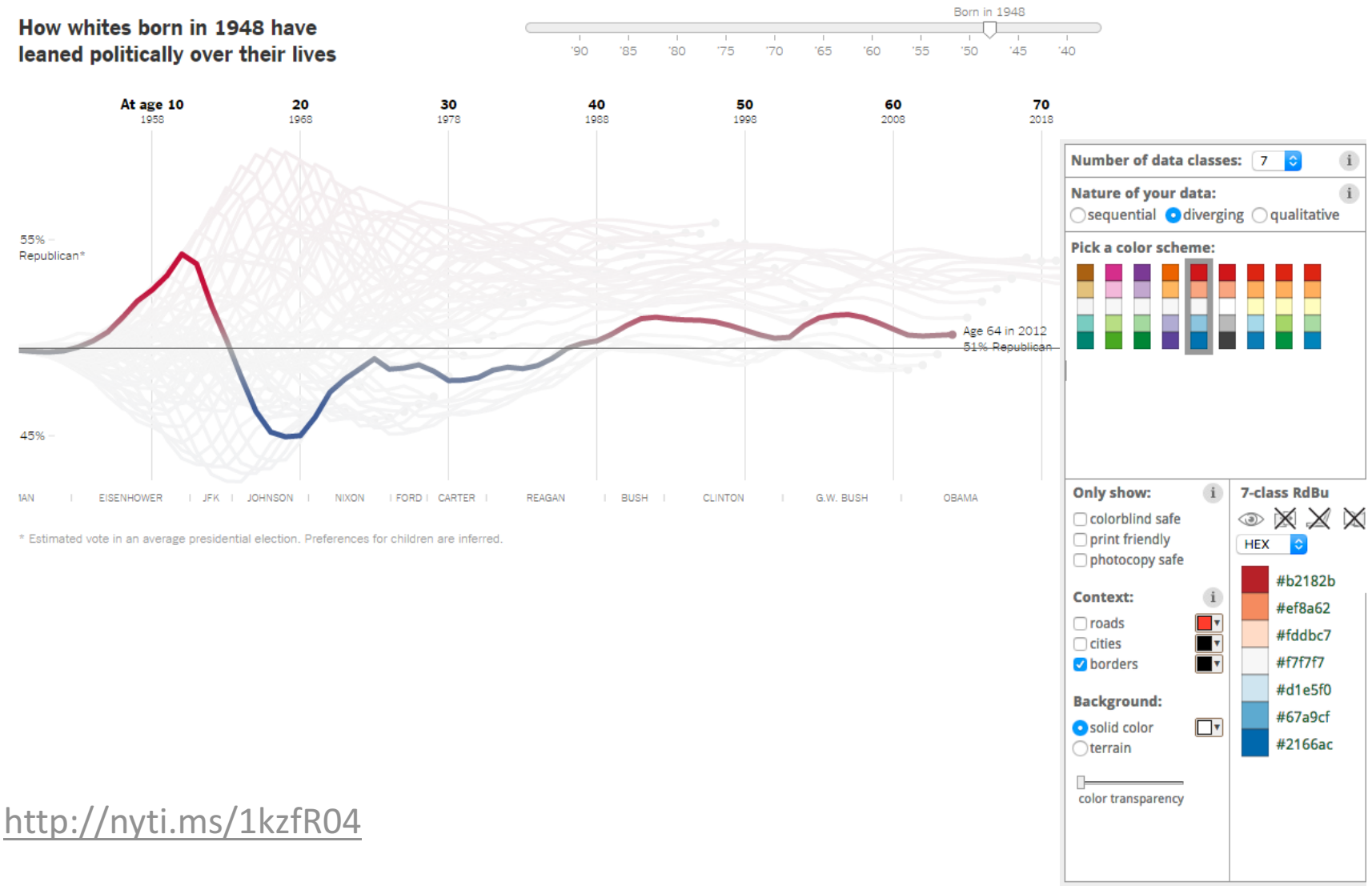
# ColorBrewer for good colormaps

http://colorbrewer2.org/



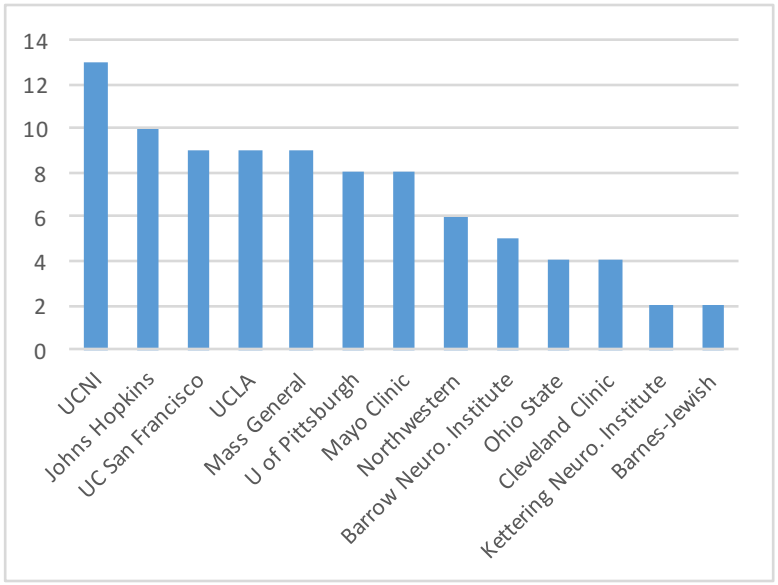
# Do data have a natural center?

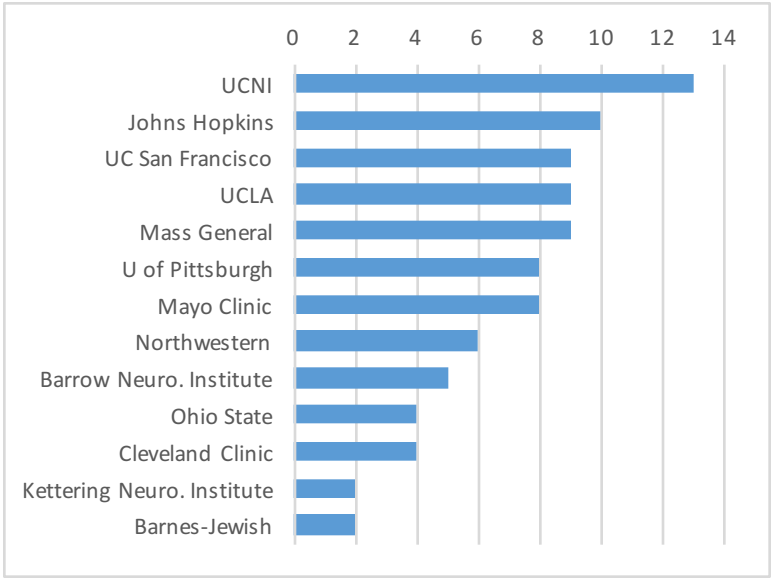



http://nyti.ms/1kzfR04

# Text to clarify

# Keep text horizontal

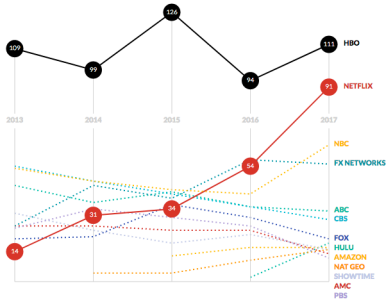



http://www.storytellingwithdata.com/2012/09/some-finer-points-of-data-visualization.html

# Annotate figures directly

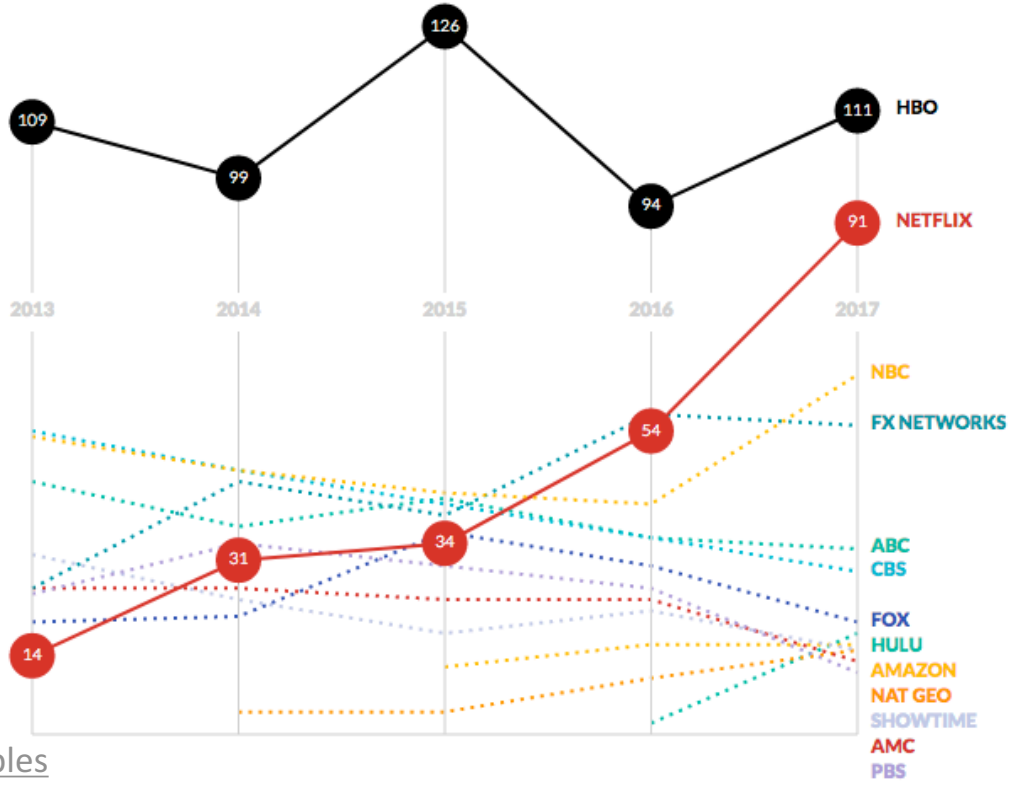

**Netflix** Challenges **HBO** at the 2017 Emmys




http://d3-annotation.susielu.com/#examples

# Annotate figures directly


**Netflix** Challenges **HBO** at the 2017 Emmys

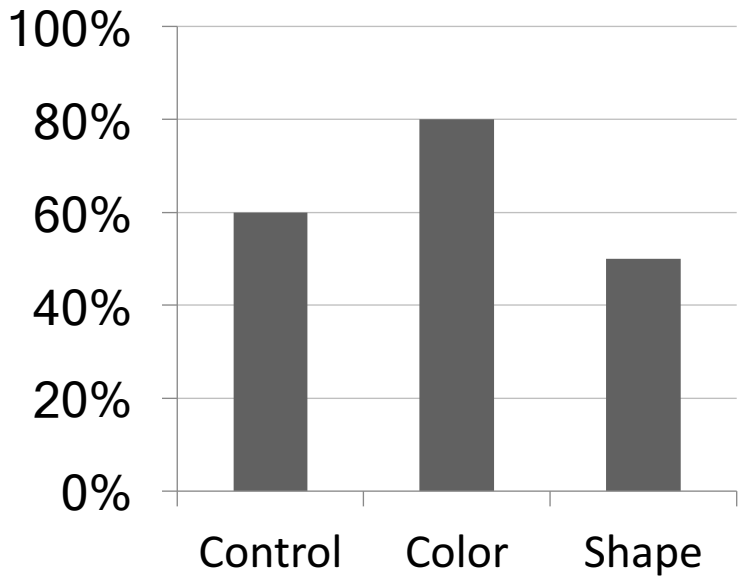



http://d3-annotation.susielu.com/#examples

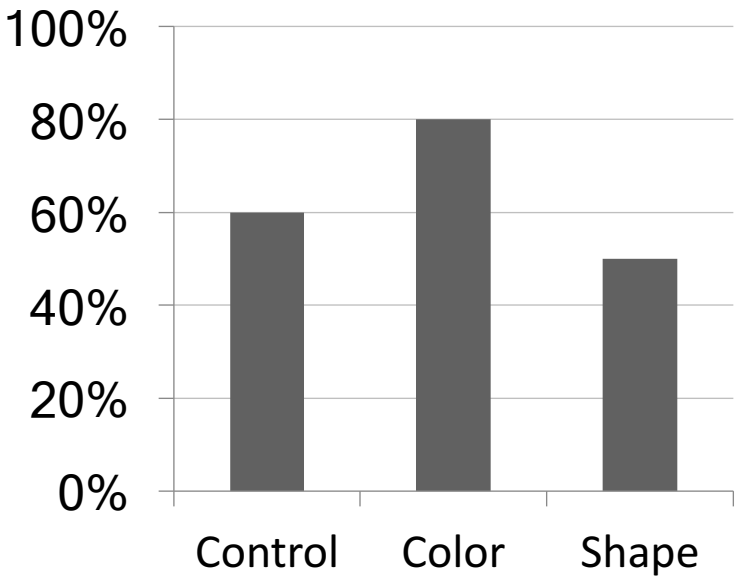
# Use descriptive titles

*Active titles summarize trends in the figure and reinforce your message.*

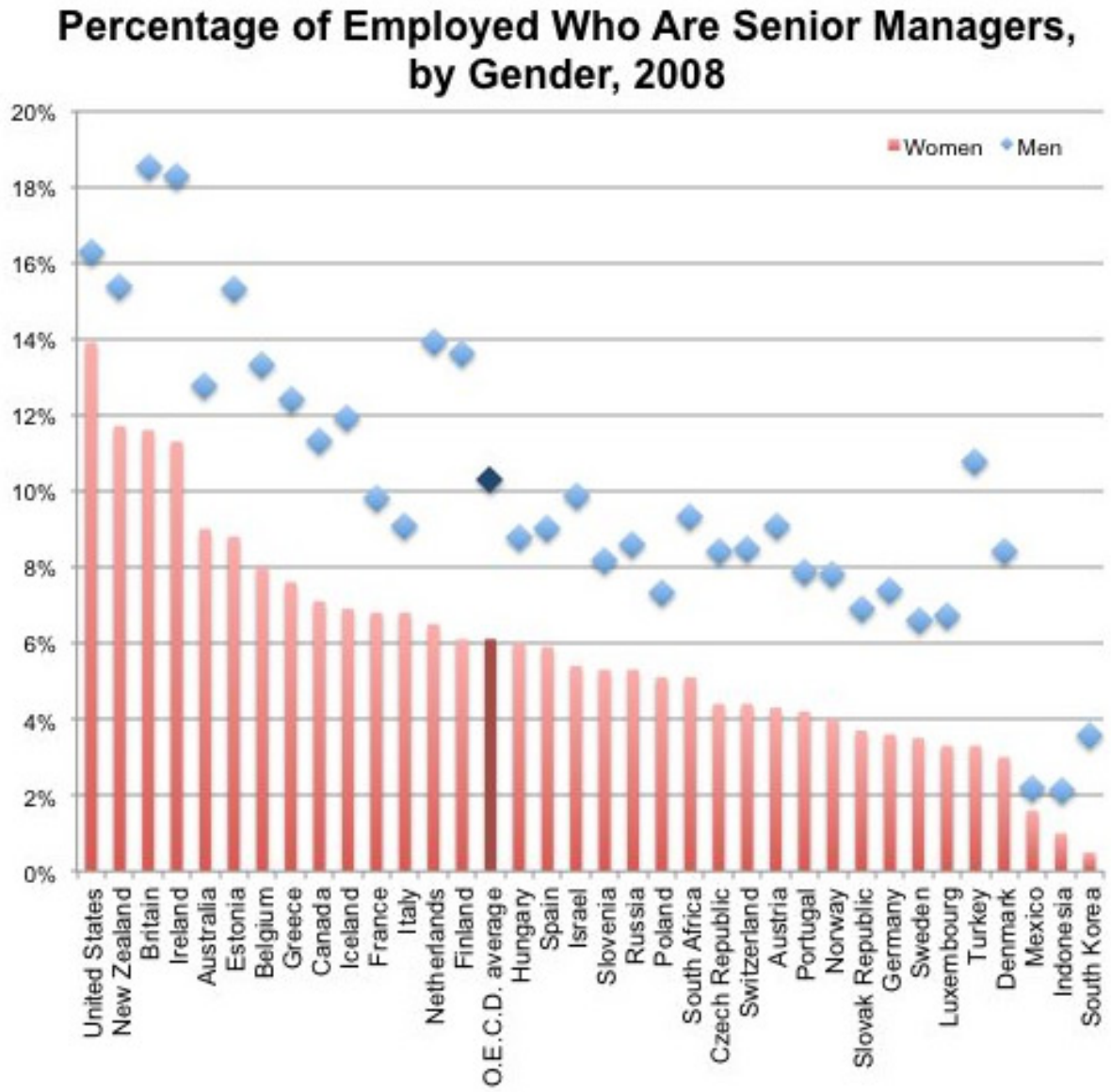
**Accuracy versus Color and Shape**




**Accuracy Improved by Color, not Shape**



# Figure rework




Jon Schwabish: http://thewhyaxis.info/gap-remake/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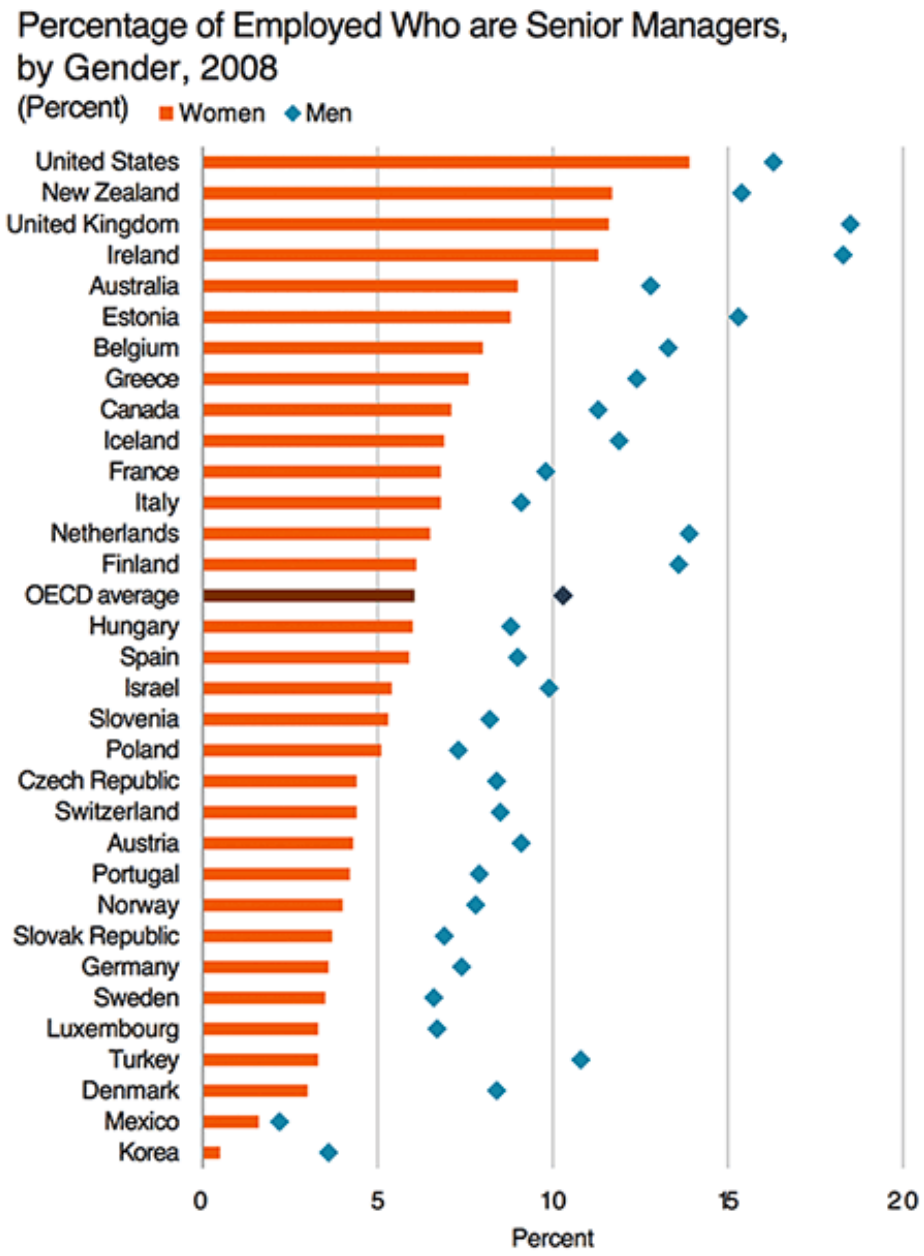


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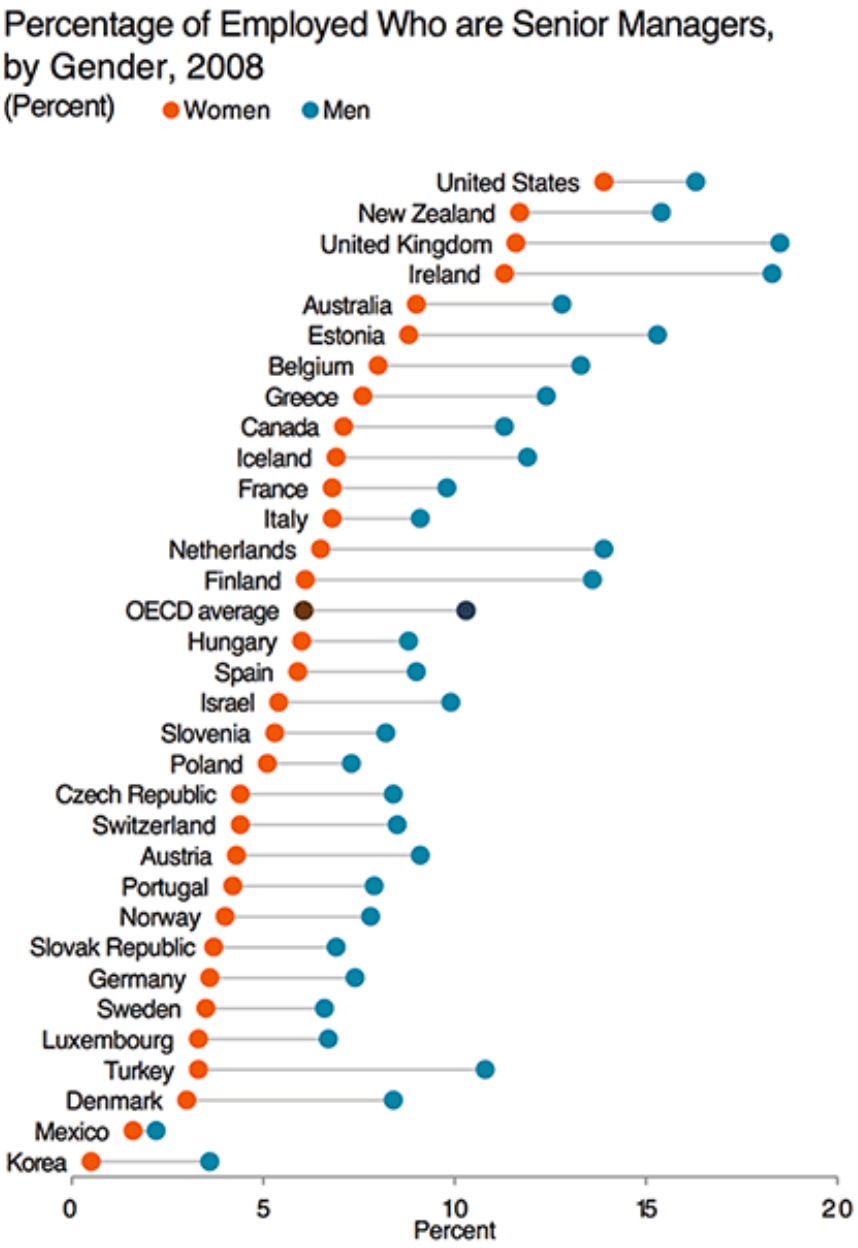
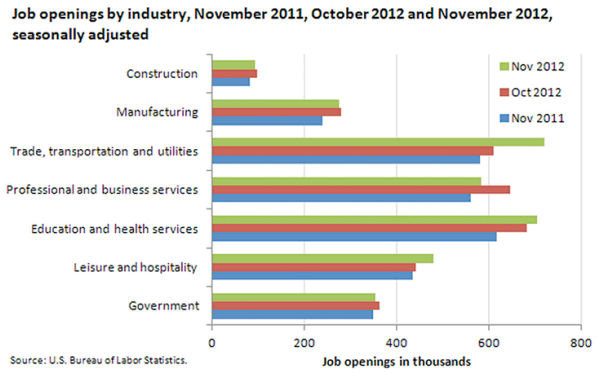
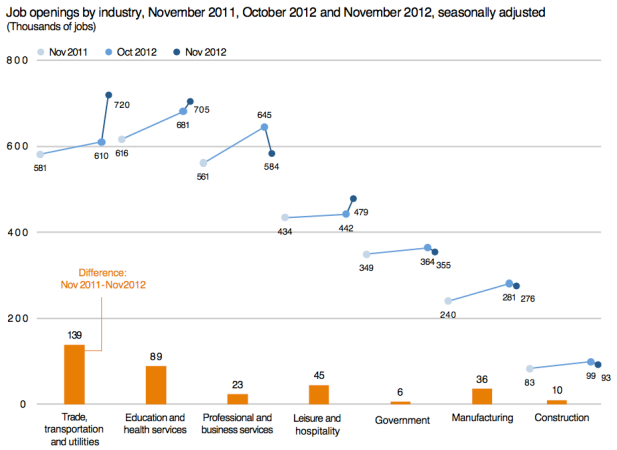



Jon Schwabish: http://thewhyaxis.info/gap-remake/

# Other chart makeover examples

The Why Axis chart remakes
http://www.thewhyaxis.info/remakes.html




Storytelling With Data visual makeovers:
https://www.storytellingwithdata.com/makeovers