Visualization: Grammar of Graphics

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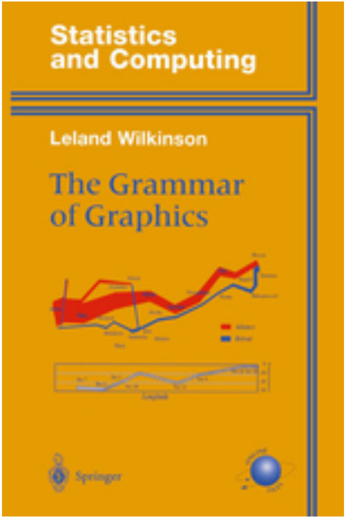
Understanding Data

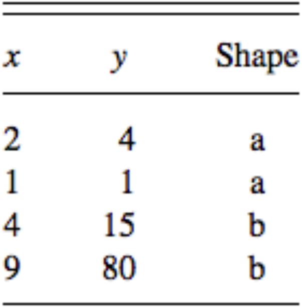
- After you’ve cleaned (wrangled) data
- Need to tell a story with the data
- Often a first step before you can build a model
- Necessary afterward to explain model works

Grammar of Graphics



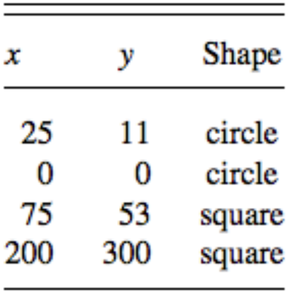
- Don’t focus on pixels
- Focus on data
- Easy combination / switches

Tiny Dataset



x	y	Shape
2	4	a
1	1	a
4	15	b
9	80	b

Data Tell a Story



x	*y*	Shape
25	11	circle
0	0	circle
75	53	square
200	300	square

What visualization helps you tell your story?

Components of a Plot

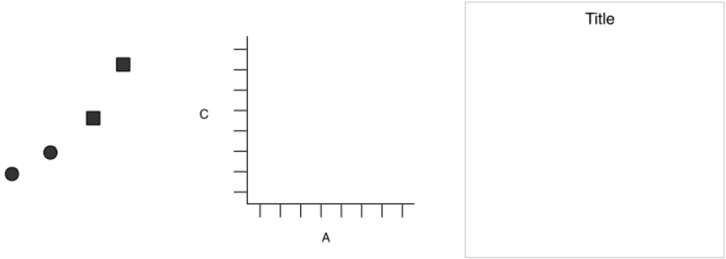
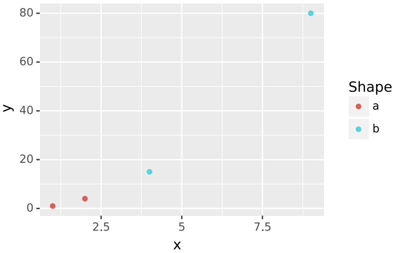


Figure 1. Graphics objects produced by (from left to right): geometric objects, scales and coordinate system, plot annotations.

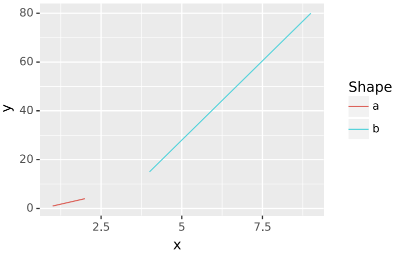
- Geom: How data turn into shapes
- Scales: Relative positioning
- Annotations: Text, explanations

Putting it Together



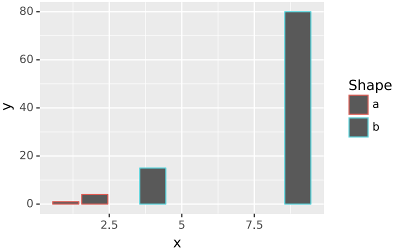
```
simple_point = (ggplot(demo,
                       aes(color='Shape', y='y', x='x')) +
                geom_point())
simple_point.save("simple_point.pdf", scale=0.6,
                  height=6, width=8)
```

Geometry Options: Line



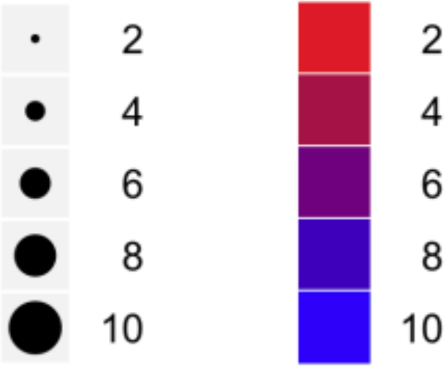
```
simple_point = (ggplot(demo,
                       aes(color=’Shape’, y=’y’, x=’x’)) +
                geom_line())
simple_point.save("simple_line.pdf", scale=0.6,
                  height=6, width=8)
```

Geometry Options: Bar



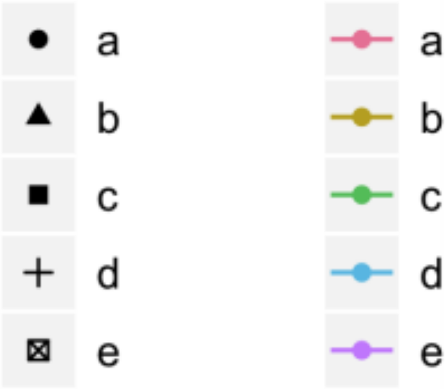
```
simple_point = (ggplot(demo,
                       aes(color='Shape', y='y', x='x')) +
               geom_bar(stat="identity"))
simple_point.save("simple_bar.pdf", scale=0.6,
                  height=6, width=8)
```

Aesthetic Options: Continuous Data



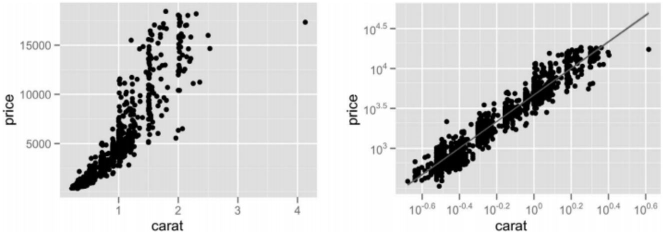
Size, color

Aesthetic Options: Discrete Data

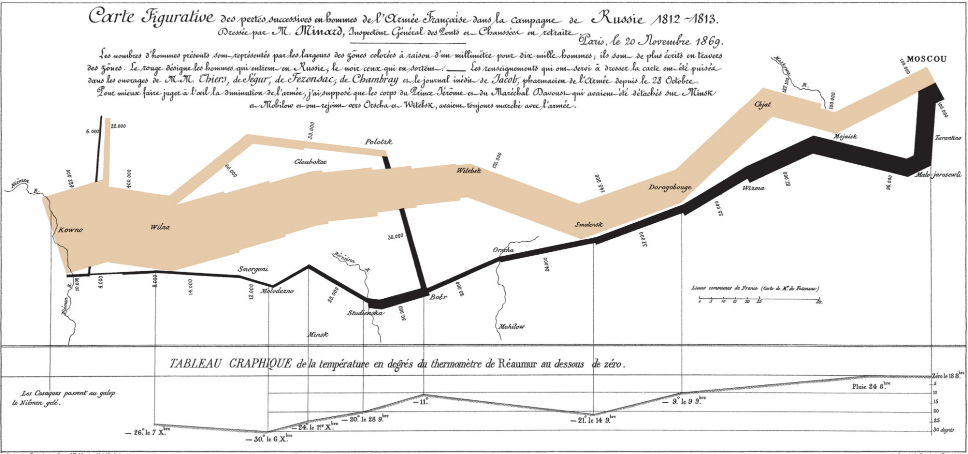


Shape, color

Rescaling Data



```
+ scale_x_log10()
```



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

Dressée 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; ils sont de plus écrits en travers des zônes. 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 MM. Thiers, de Ségur, 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 Davoust qui avaient été détachés sur Minsk et Mobilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.

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

Autog. par Regnier, 8. Pas. Ste Marie St Gain à Paris.

Imp. Lith. Regnier et Dourdet.

Edward Tufte on Charles Joseph Minard

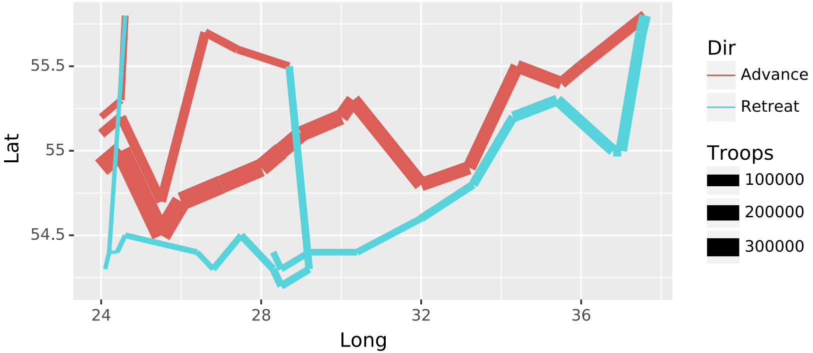
Data (Troops)

```
Long,Lat,Troops,Dir,Div
24.0,54.9,340000,Advance,1
24.5,55.0,340000,Advance,1
24.2,54.4,4000,Retreat,2
24.1,54.3,4000,Retreat,2
24.6,55.8,6000,Retreat,3
24.2,54.4,6000,Retreat,3
```

Cities

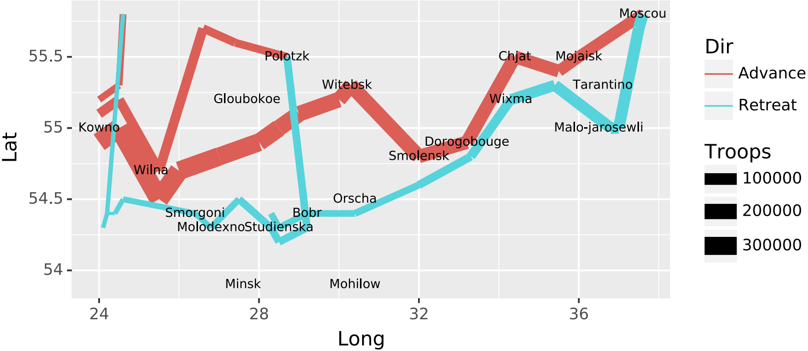
```
Long,Lat,City
24.0,55.0,Kowno
25.3,54.7,Wilna
26.4,54.4,Smorgoni
26.8,54.3,Molodexno
27.7,55.2,Gloubokoe
27.6,53.9,Minsk
```

Plot Troops



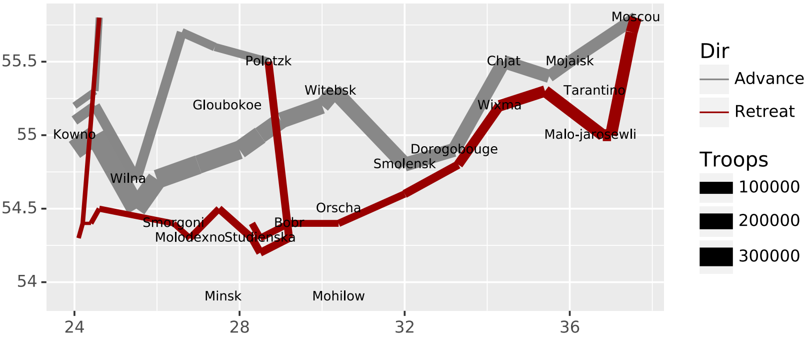
```
plot_troops = (ggplot(troops, aes('Long', 'Lat')) +
                    geom_path(aes(size = 'Troops',
                                  color = 'Dir',
                                  group = 'Div')))
```

Add Cities



```
both = plot_troops + geom_text(aes(label='City'),
                              size=7, data=cities)
```

Make Prettier



```
polish = both + scale_color_manual(["#888888", "#990000"])
```

Practicalities

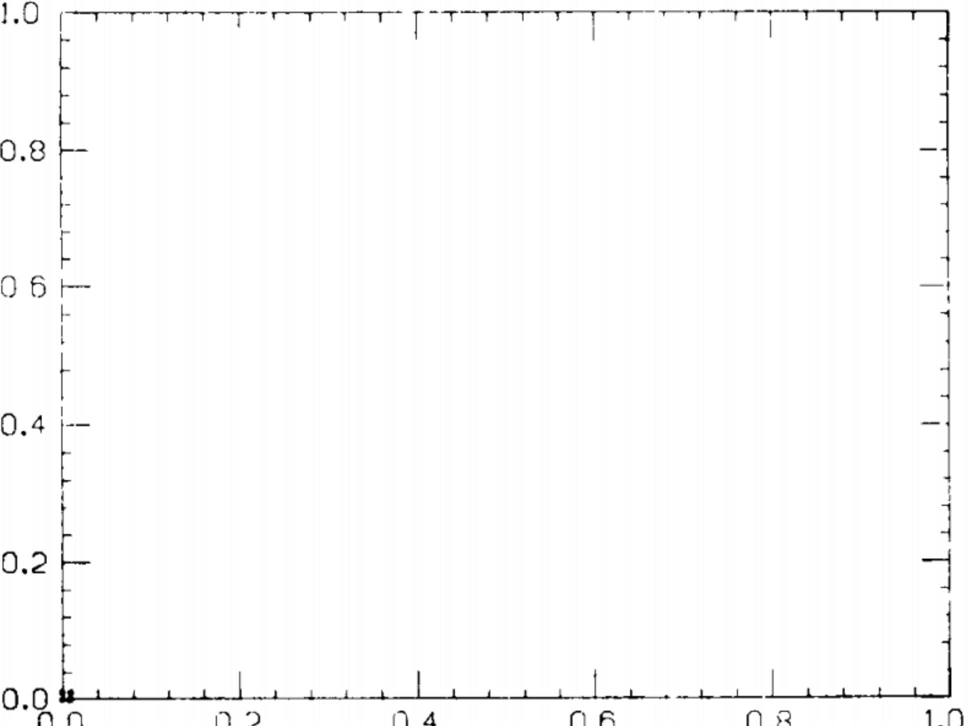
- Remember to have data in accessible directory
- Install plotnine (e.g., with pip)
- Keep track of how you generate every plot

Tips

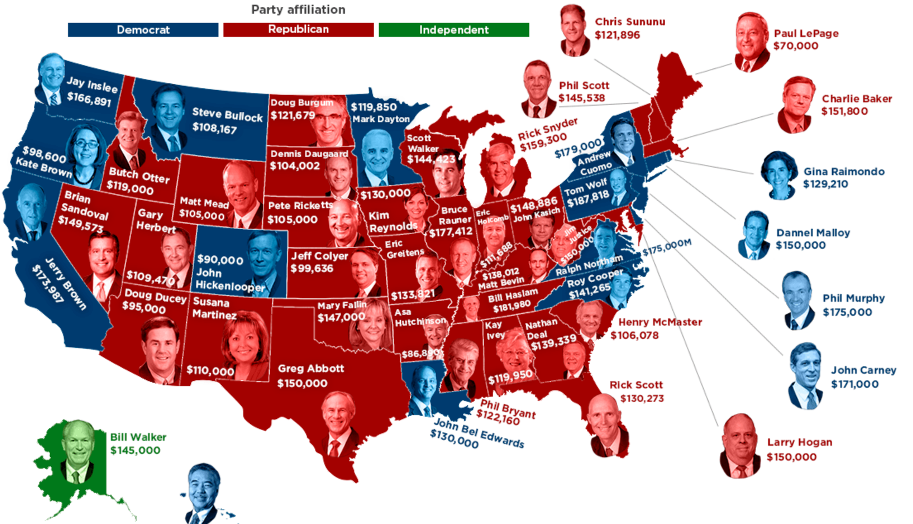
- Avoid clutter
- Organize logically, not arbitrarily
- Encourage / enable comparisons
- Don’t overload with variables
- Overplotting

Tips

- Avoid clutter
- Organize logically, not arbitrarily
- Encourage / enable comparisons
- Don’t overload with variables
- Overplotting
- Examples of what not to do


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

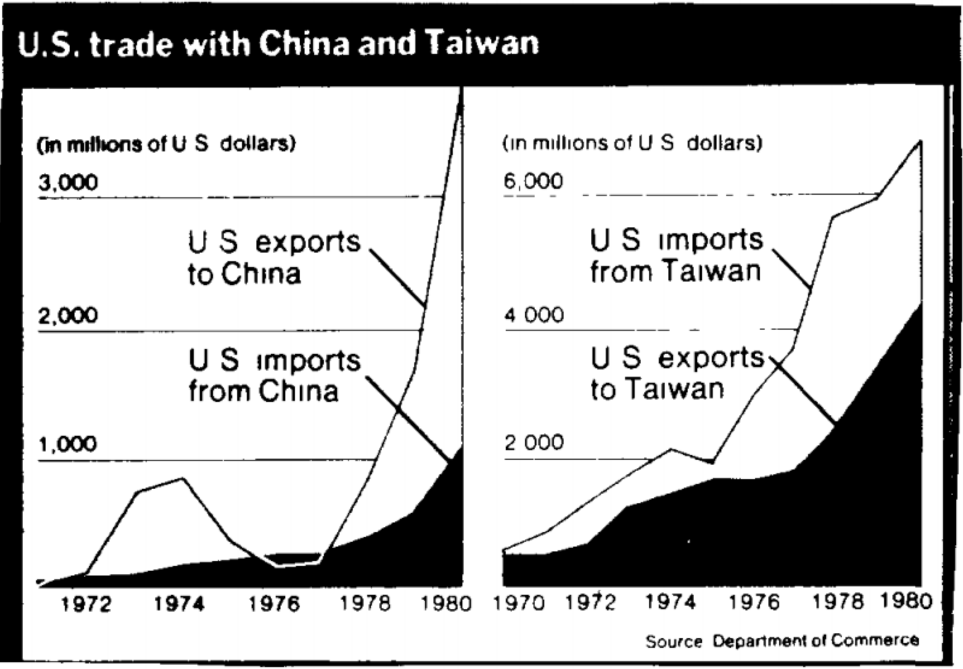
Every Governor's Salary by State



Article & Sources:
https://howmuch.net/articles/every-governors-salary-by-state
https://ballotpedia.org

howmuch.net

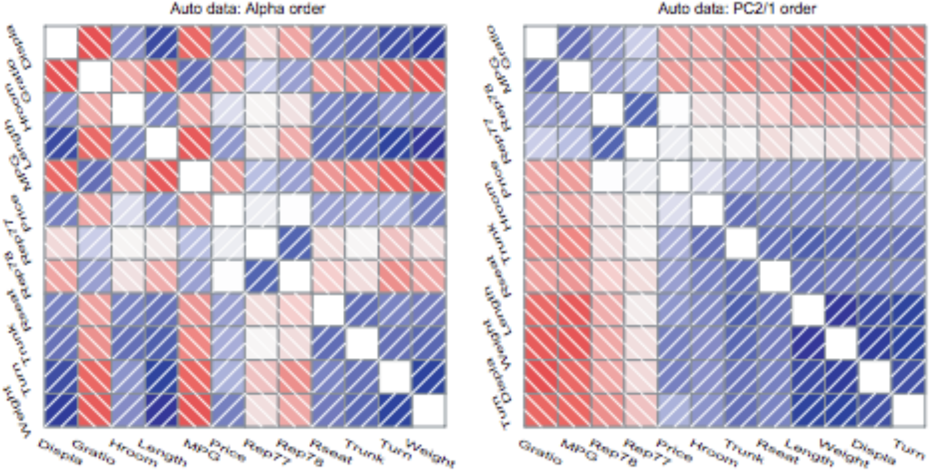
Reflect data



U.S. trade with China and Taiwan

Source Department of Commerce

Enable comparisons



Auto data: Alpha order

Auto data: PC2/1 order

Order sensibly

Wrap Up

- Cleanup
- Explore
- Model
- Copy
- Explain