

Same Data, Different Chart

How the form we choose for data affects what users can see

By Erica Gunn

UXPA Boston, 10.23.2020



@EricaGunn

#UXPABos2020, #bookTopics

Let me know what topics you would most like to see in future articles and my book

Agenda

Part I: What is data visualization?

Part II: Matching chart to task

Conclusions and takeaways

Part I:

What *is* data visualization?

Definitions of data vis

What makes up a chart

What *is* data visualization?

Answer #1: *Philosophical*

Data visualization is the practice
of giving **form** to the **abstract and unseen**.

→ *Design challenge*

What *is* data visualization?

Answer #2: *Description*

A Data Visualization:

- **Encodes** information
- Converts **data channels** (variables) into visual form
- Uses **marks** to represent the data values

→ *Technical challenge*

What *is* data visualization?

From Data To Chart

Objects or Observations



Data (measurement)

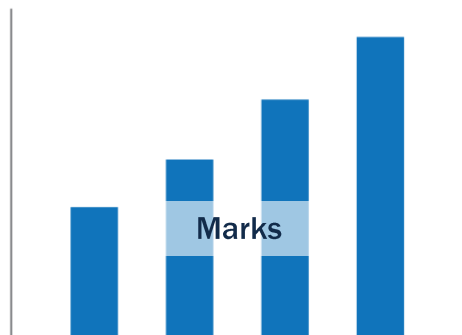
	A	B
1	Age (y)	Height (in)
2	4	40
3	8	51
4	12	58
5	16	67.5
6		

Channel and Encoding

Channel 1: Height
Encoding: Length

Channel 2: Age
Encoding: Position

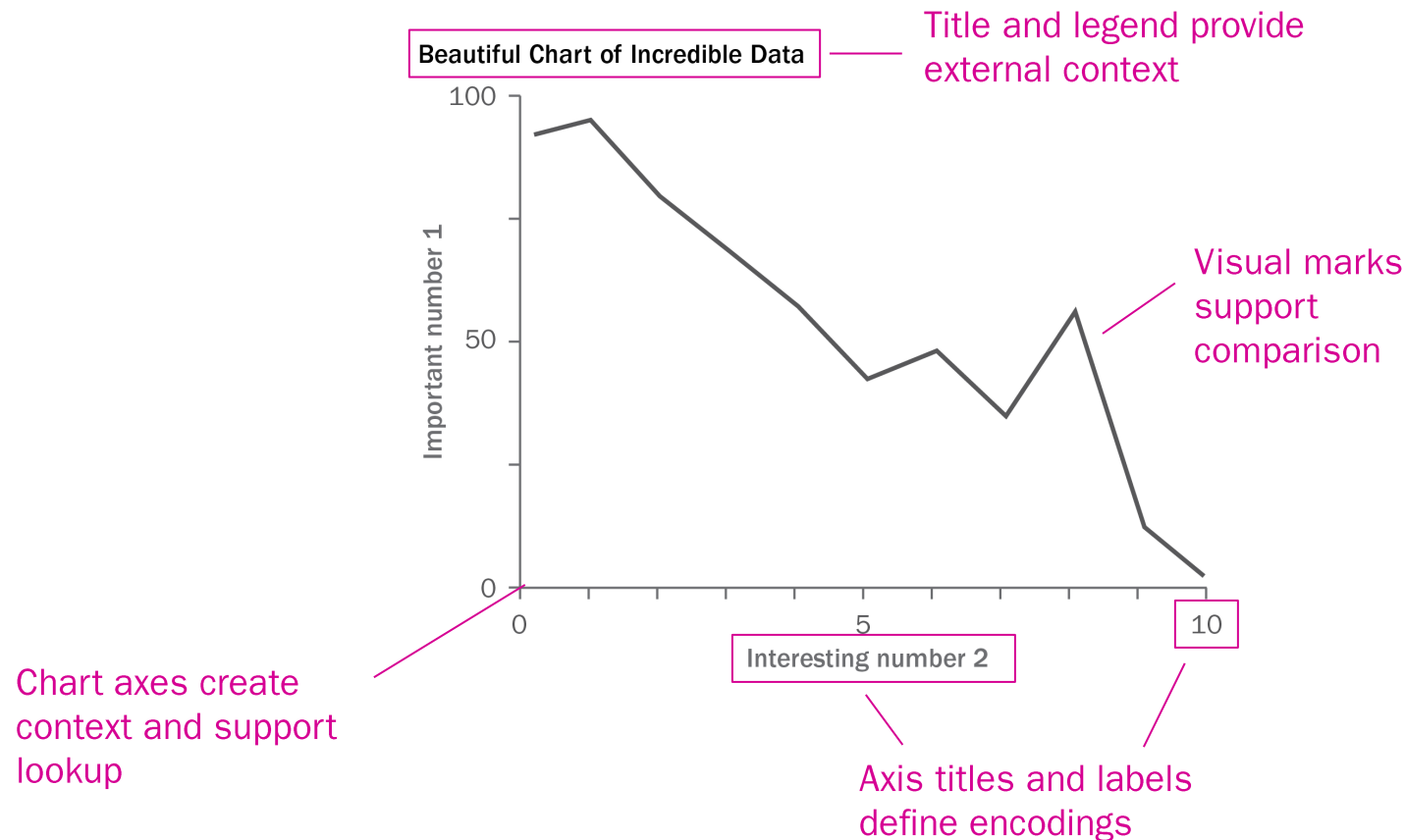
Chart



What *is* data visualization?

Anatomy of a Chart

Every part of a chart has a job to do

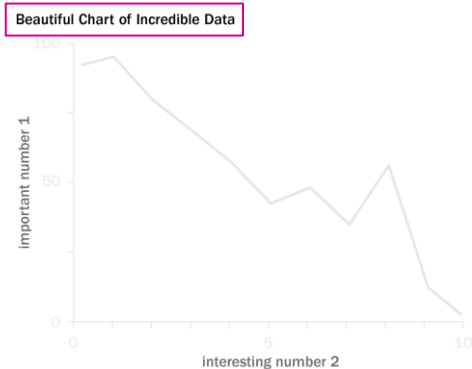


What *is* data visualization?

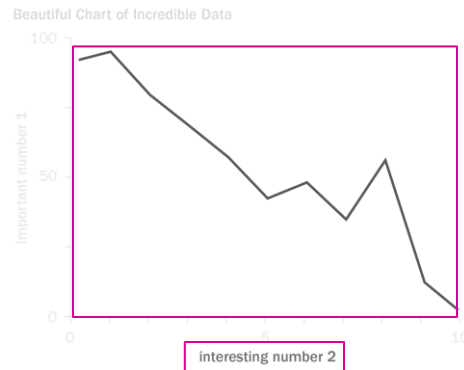
Journey to Understanding

A user understands a chart in a series of steps

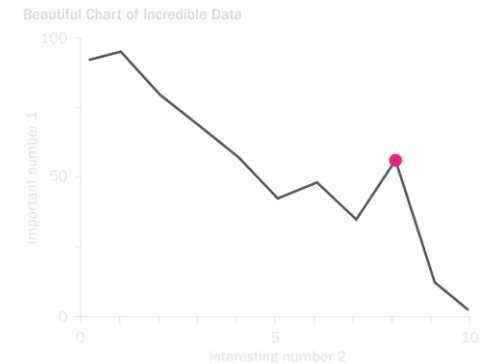
External Identification



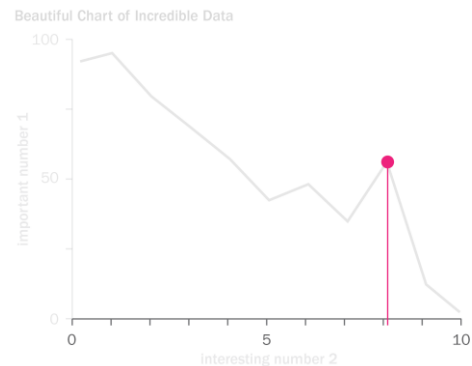
Recognize Encoding



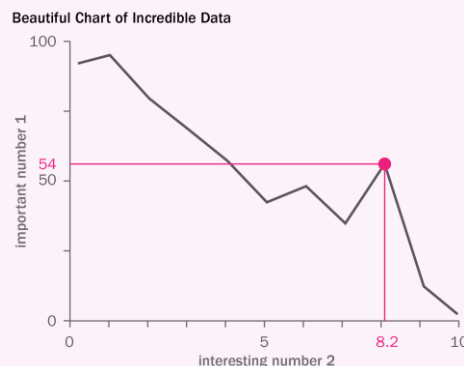
Query Details



Internal Identification



Synthesis and Understanding

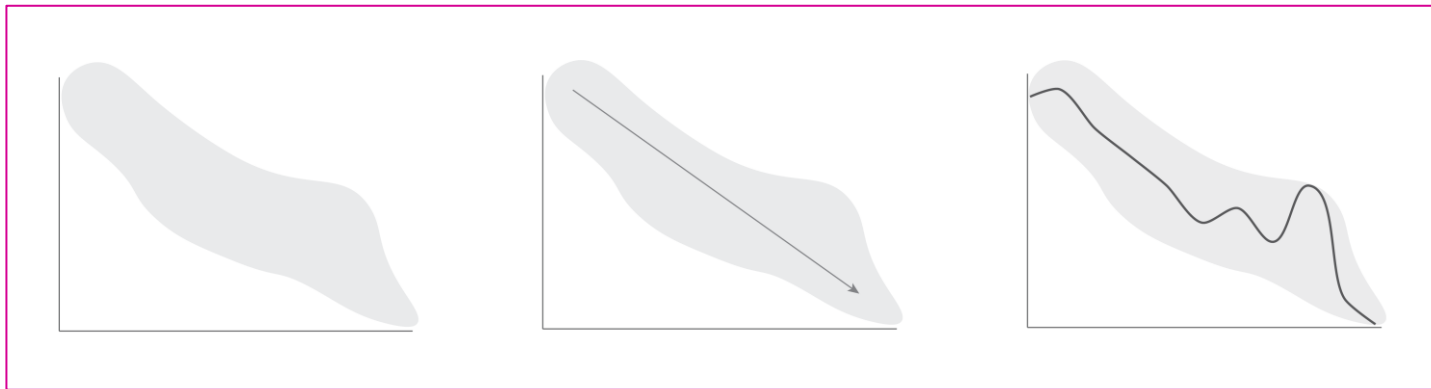


If we don't get our user here, the chart has not done its job.

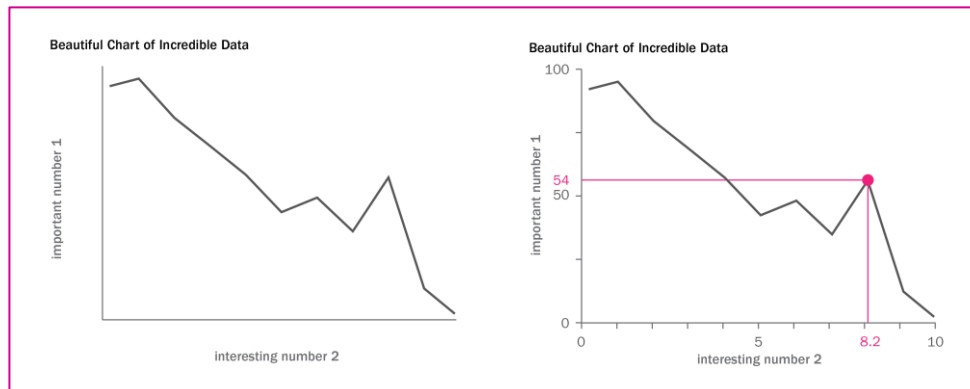
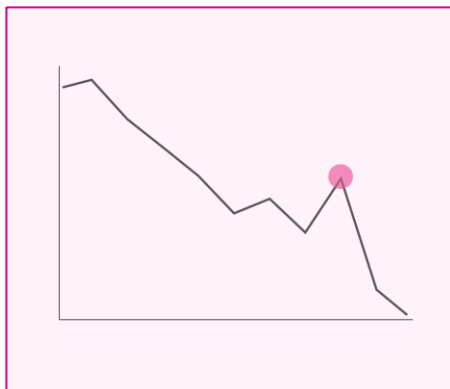
What *is* data visualization?

Thinking, Visually

Reading a chart relies on two kinds of visual cognition



Preattentive Processing:
Fast, easily fooled



Attentive Processing:
Slower, deliberate, more effortful

User Engagement:
Deciding to read the chart

Connecting Chart to Persona



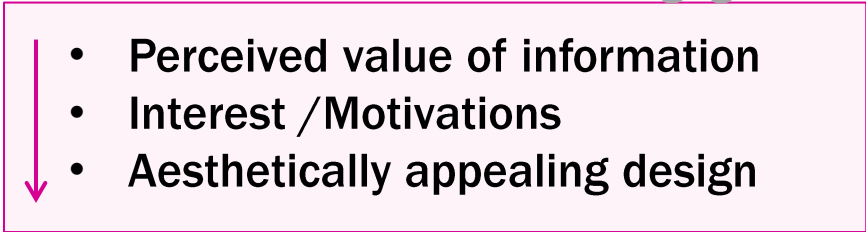
CEO

“I want it to jump out at me, right off the page”

Preattentive Processing

- Familiar encodings
- Gestalt principles
- Increase salience

User Engagement

- 
- Perceived value of information
 - Interest / Motivations
 - Aesthetically appealing design

Attentive Processing

“First and foremost, a chart needs to be useful”

- Appropriate chart
- Design decisions support the analytical task



Data Analyst

What *is* data visualization?

Answer #3: *Purpose*

Data visualization is a form of
visual communication
that supports a user task

→ *UX challenge*

Part II:

Matching Chart to Task

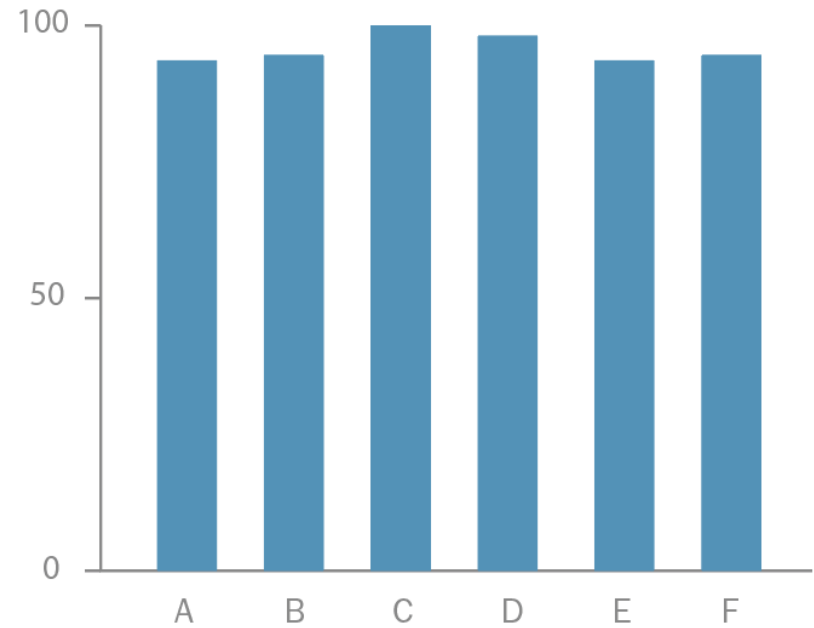
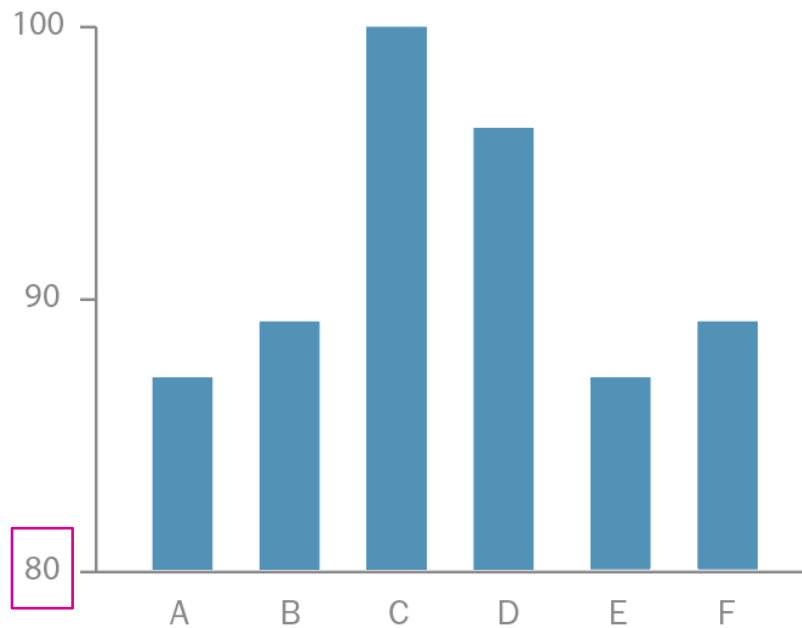
- Setting some ground rules
- Connecting chart to task
- Exploring the options
- Leveraging design principles

Data visualizations should:

- 1. Accurately represent information,
without distortion or undue emphasis.**

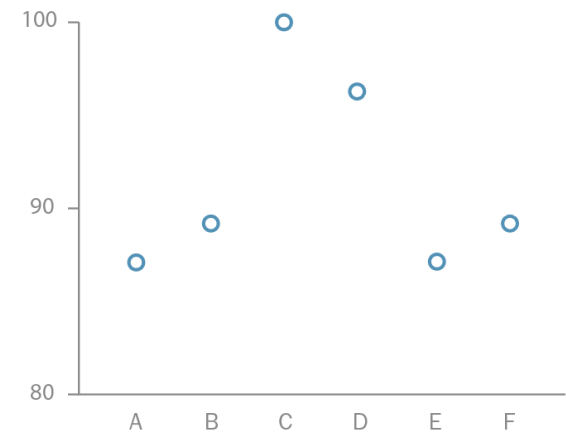
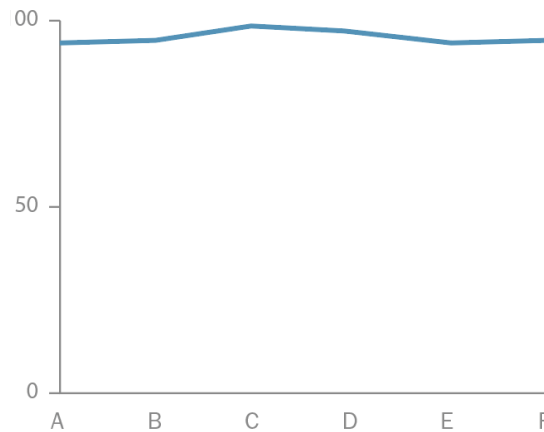
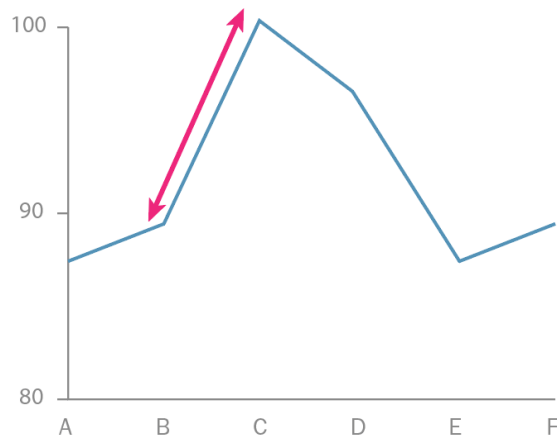
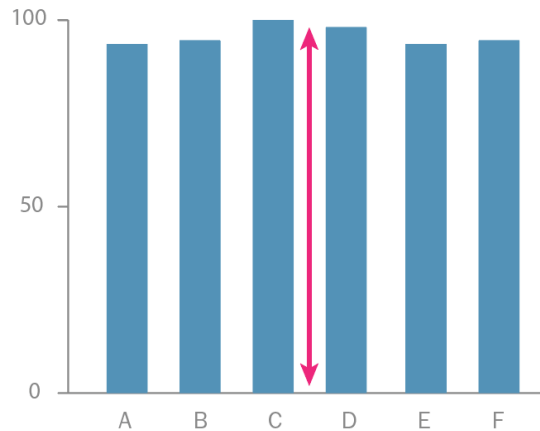
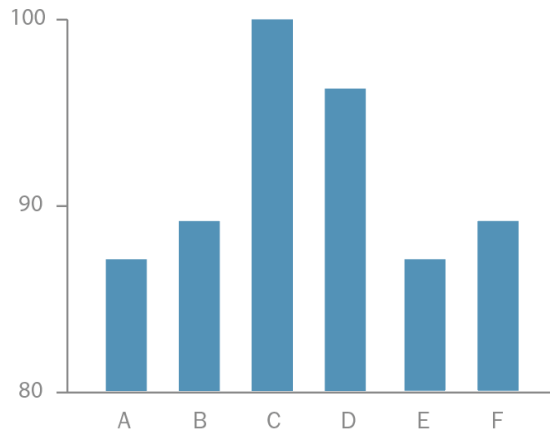
Don't Do This #1: Nonzero Y

Bar chart axes should start at zero



Marks Matter #1

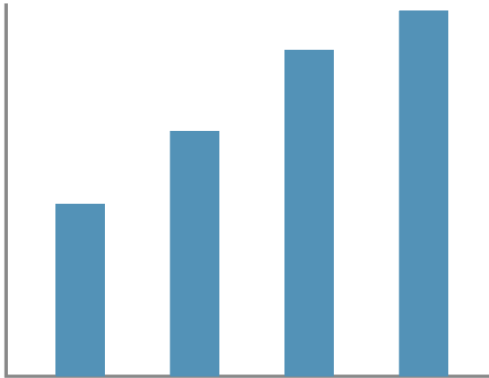
Best practices optimize for what the user needs to read the chart



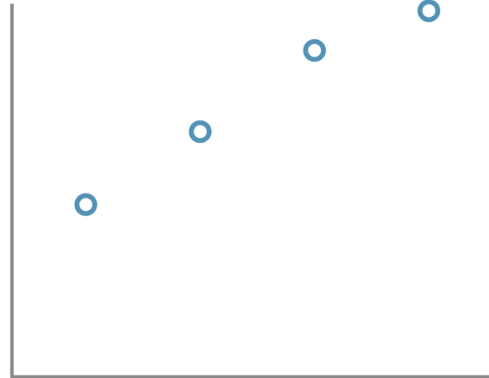
Marks Matter #2

How you draw the data affects what you see

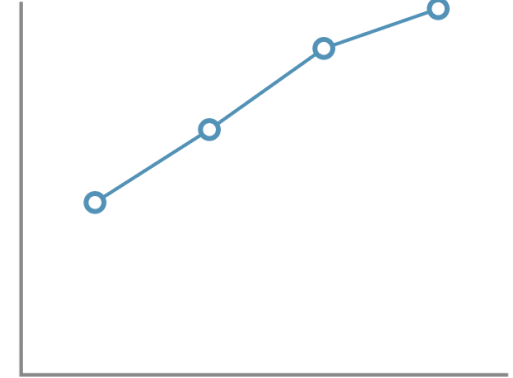
Compare bar height



Read dot values



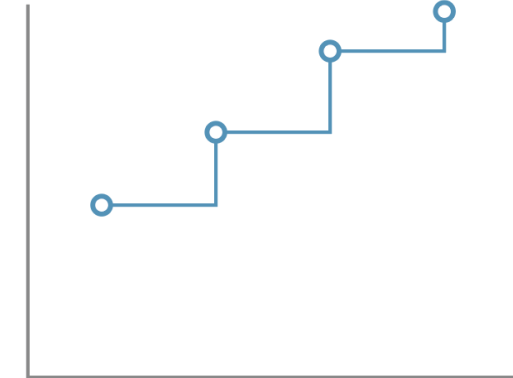
See change btwn points



Focus on area under curve

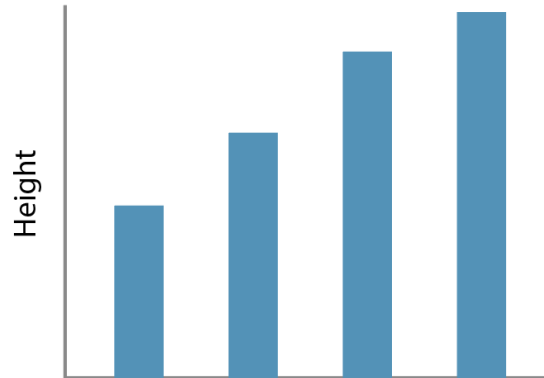


See size of change

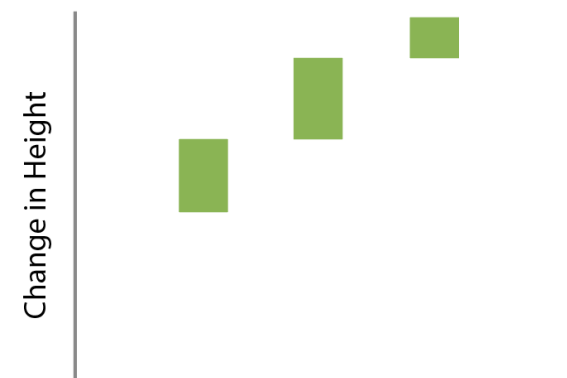
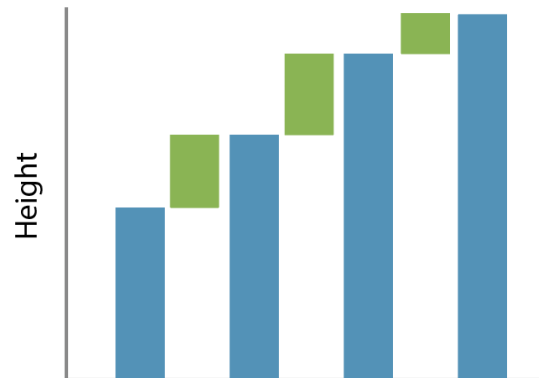


Change the Channel

Redefining a channel can emphasize different aspects of the data



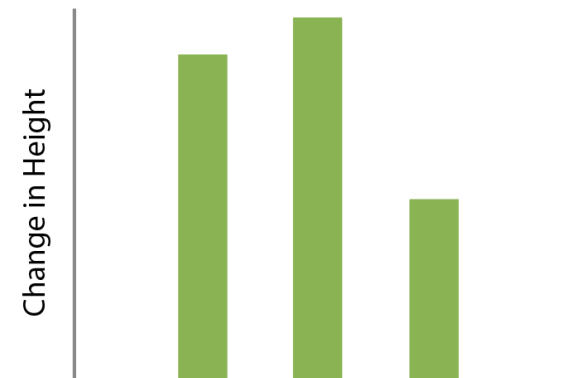
How tall is Bob?



How much has Bob grown this year?

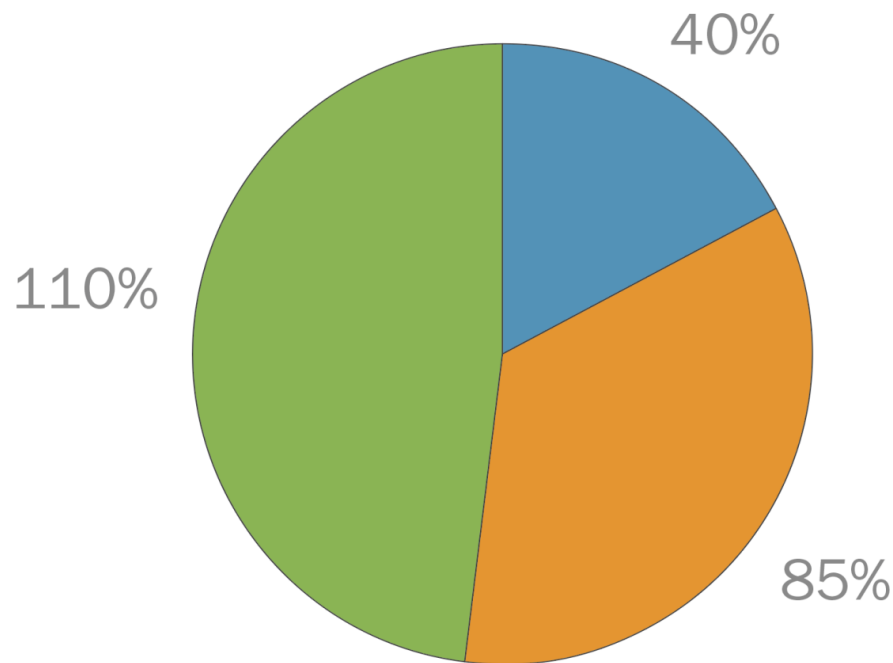


Be careful with derived statistics; they can add unintended emphasis



Don't Do This #2: Percentage scaling

Percentages in a pie chart must always add up to 100



The number that I read should not contradict what my eyes see!

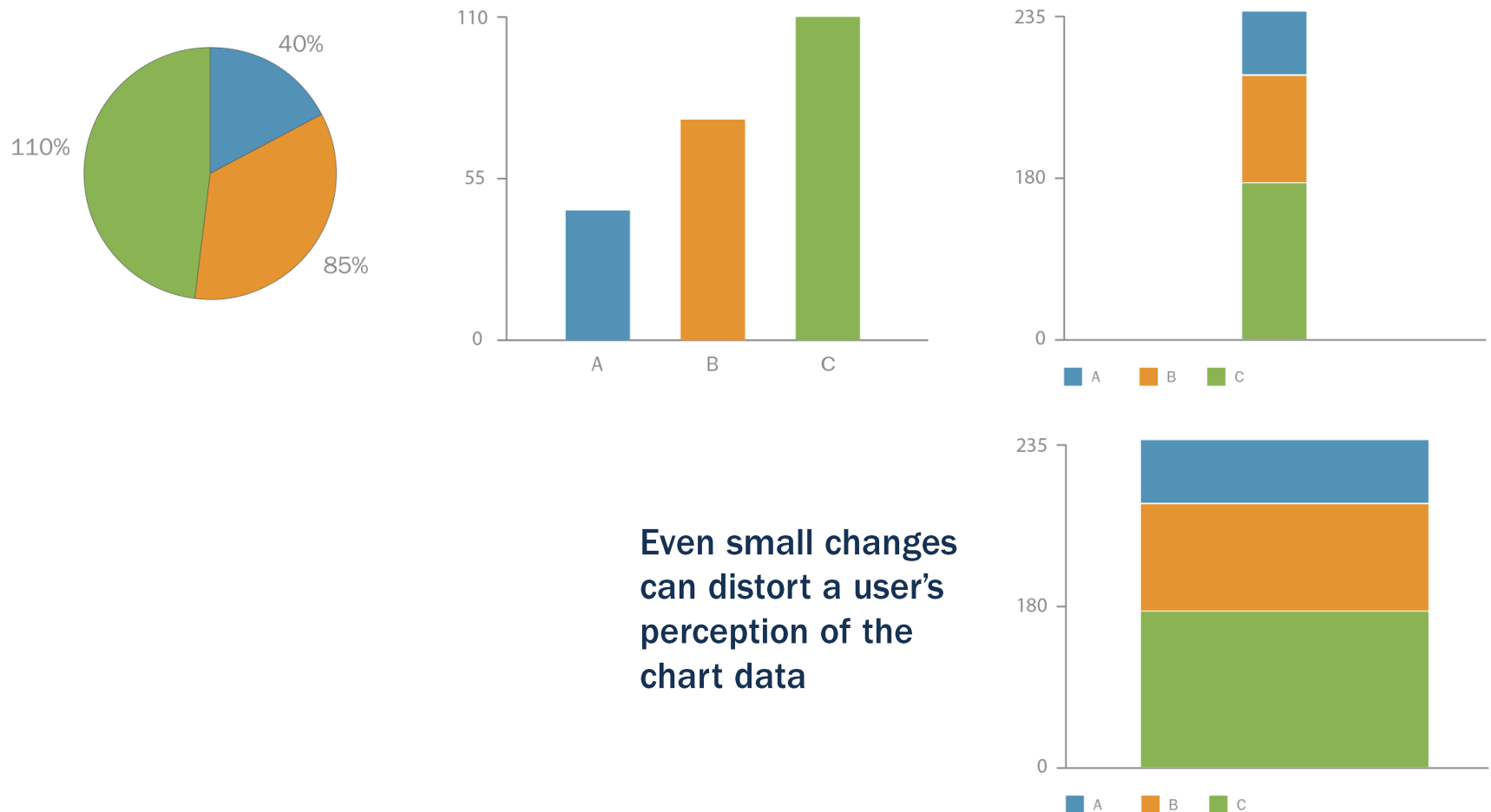
1 pie = 100%

Values = 235%

???

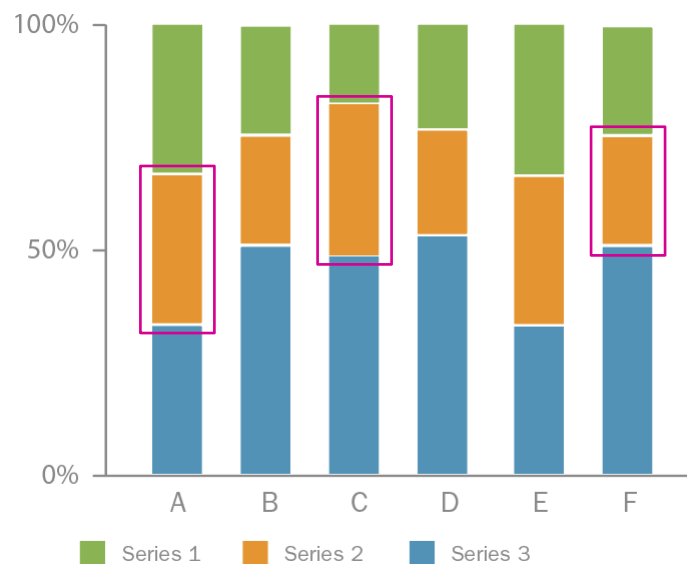
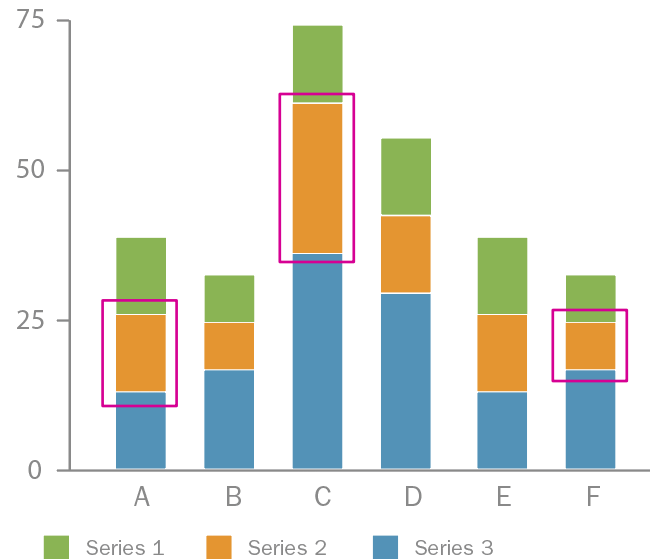
Do This Instead: Percentage scaling

Bars don't add up to a whole, so they can represent more than 100%



Don't Do This #3: Percentage scaling

Be careful with percentages in proportional representations in general



Data visualizations should:

2. Have a **purpose.**

Audience: Who am I talking to?

Context: What kind of information do they need?

Know Your Audience

A chart's purpose dictates appropriate design choices

CRYSTAL
GROWTH
& DESIGN

Does Crystal Density Control Fast Surface Crystal Growth in Glasses? A Study with Polymorphs

Published as part of a virtual special issue of selected papers presented at the 2010 Annual Conference of the British Association for Crystal Growth (BACG), Manchester, UK, September 5–7, 2010

Erica M. Gunn, Ilia A. Guzei, and Lian Yu*

School of Pharmacy and Department of Chemistry, University of Wisconsin - Madison, Madison, Wisconsin 53705, United States

ABSTRACT: As organic liquids are cooled to become glasses, crystal growth at the free surface can be substantially faster than in the interior, a phenomenon uncommon for other materials and for which different explanations exist. We have measured the surface and bulk growth rates of three polymorphs in carbonaceous glasses. Crystal density has no controlling effect on the extent to which surface crystal growth is enhanced over bulk crystal growth, in contradiction to models that relate fast surface crystal growth to the release of crystallization-induced tension.

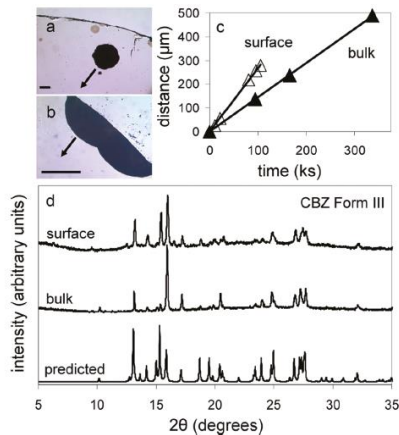
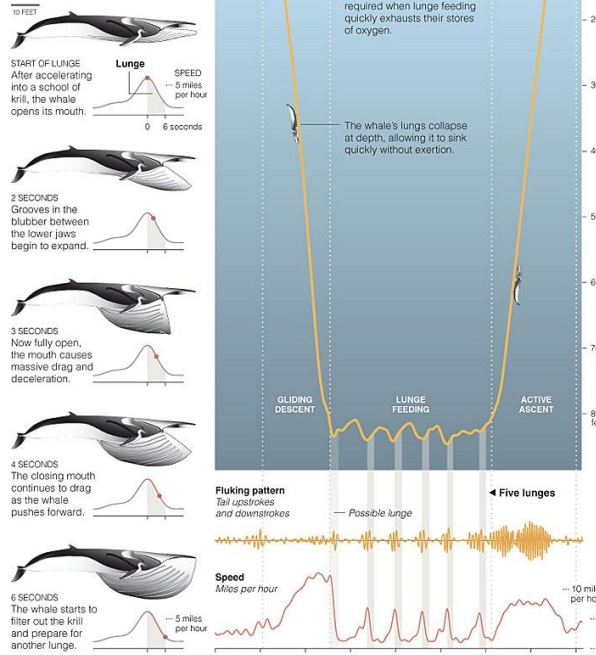


Figure 3. Form III crystals growing (a) at the surface and (b) in the bulk at 313 K. Scale bar = 200 μm. Arrows indicate growth directions. (c) Distance of growth vs time for crystals in (a) and (b). (d) Observed and predicted XRD patterns of Form III crystals.

Lunge Feeding

Scientists tracking fin whales have created the first detailed model of how they feed. After gliding to depths of more than 600 feet in search of krill, a fin whale will repeatedly accelerate and open its mouth wide, engulfing about 20 pounds of krill and more than its own weight in water as it grinds to a halt.



Sources: Jeremy A. Goldbogen; Nicholas D. Pyenson; Journal of Experimental Biology; Marine Ecology Progress Series

- Tone
- Sequence
- Level of complexity
- Quantitative accuracy
- Compactness
- Level of abstraction
- Annotations
- Details/emphasis
- User controls

Know Your Message

What kind of a point are you trying to make?



Data visualizations should:

3. Have a **perspective**.

Who measured the data?

What perspective does it reflect?

Who is represented, how, and why?

Data is *Always* Socially Situated



Georgia Lupi: <http://giorgialupi.com/bruises-the-data-we-dont-see/>
Johanna Drucker: Graphesis. Visual Forms of Knowledge Production

Data visualizations should:

4. **Help people understand**
something about the data
that they might not
otherwise have seen.

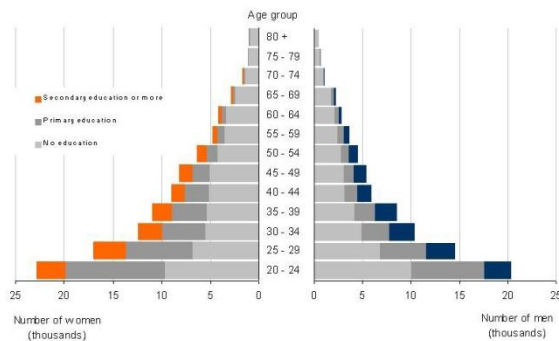
5. **Support a user task.**

What does your user need to do, or see?

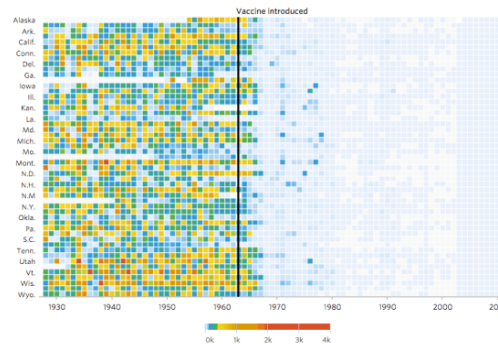
Different Charts for Different Tasks

Charts can support different tasks

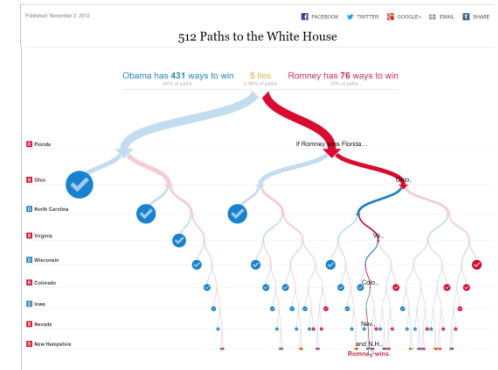
Compare objects side by side



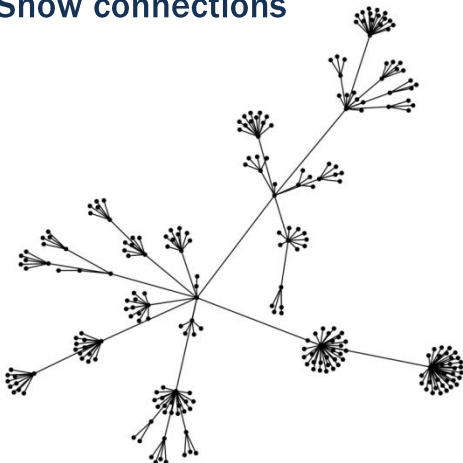
Group things together



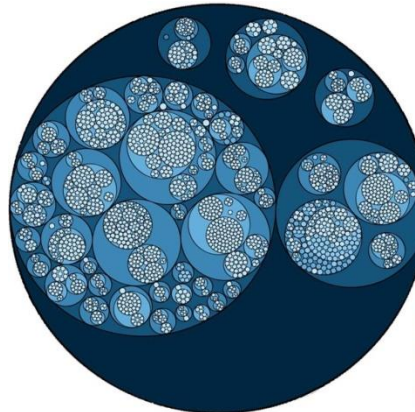
Narrate a sequence of events



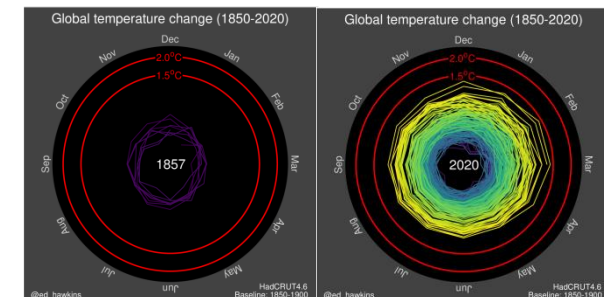
Show connections



Show membership



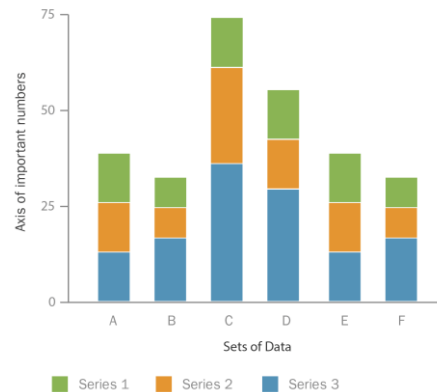
Explain how things change



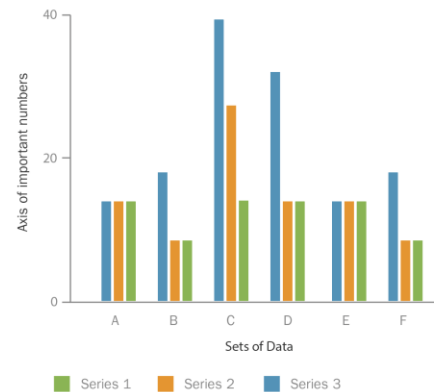
Charts Facilitate Comparison

Choosing the right encoding helps the user to understand your data.

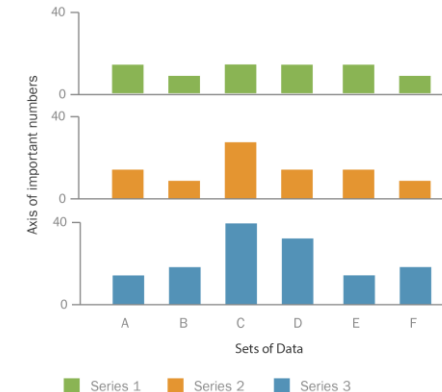
Stacked bar chart



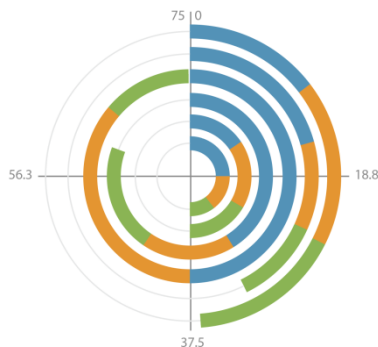
Grouped bar chart



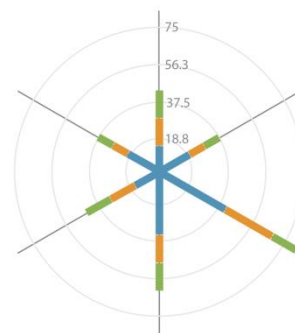
Small multiples bar charts



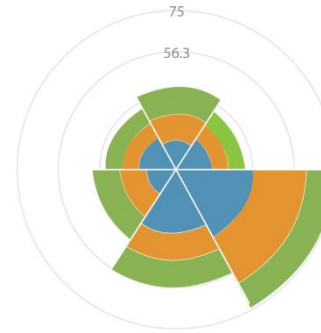
Racetrack chart



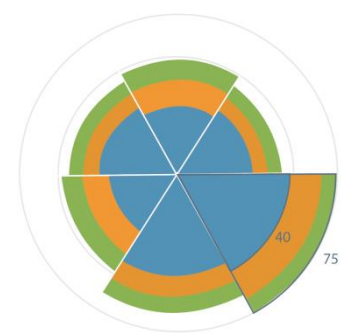
Radial bar chart



Rose diagram (length)



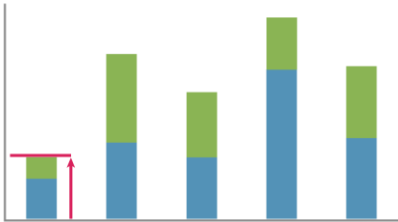
Rose diagram (area)



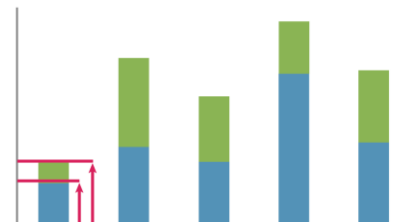
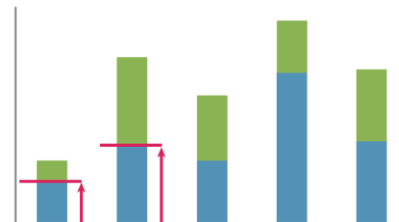
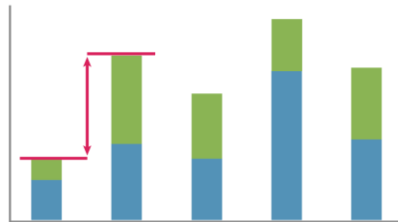
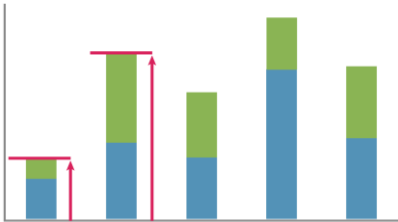
Task Inventory

What are the user tasks that your chart should support?

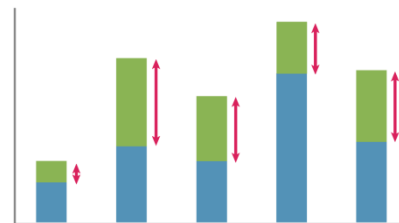
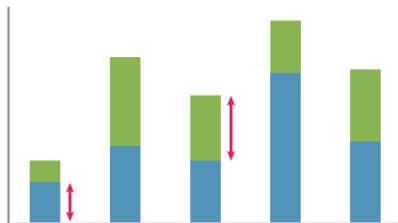
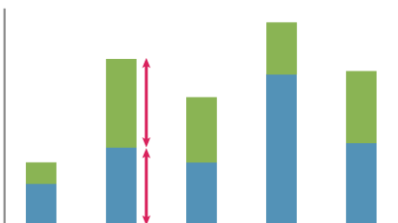
Measure Height



Compare Heights (values)



Compare Heights (proportions)



Assess Fitness for Task

Use the task information to evaluate different chart options

Stacked bar chart



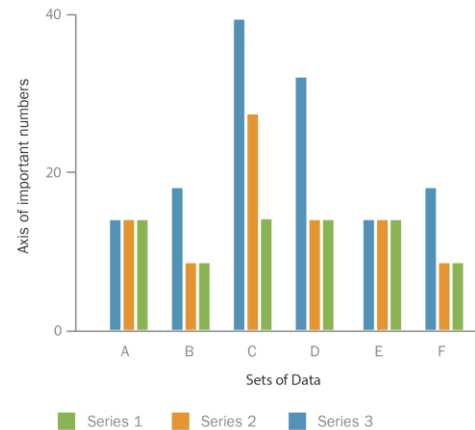
Measure Values

Compare Heights

- of bars
- of stacks
- of series

Compare proportions

Grouped bar chart



Measure Values

Compare Heights

- of bars
- of stacks
- of series

Compare proportions

Small multiples bar charts



Measure Values

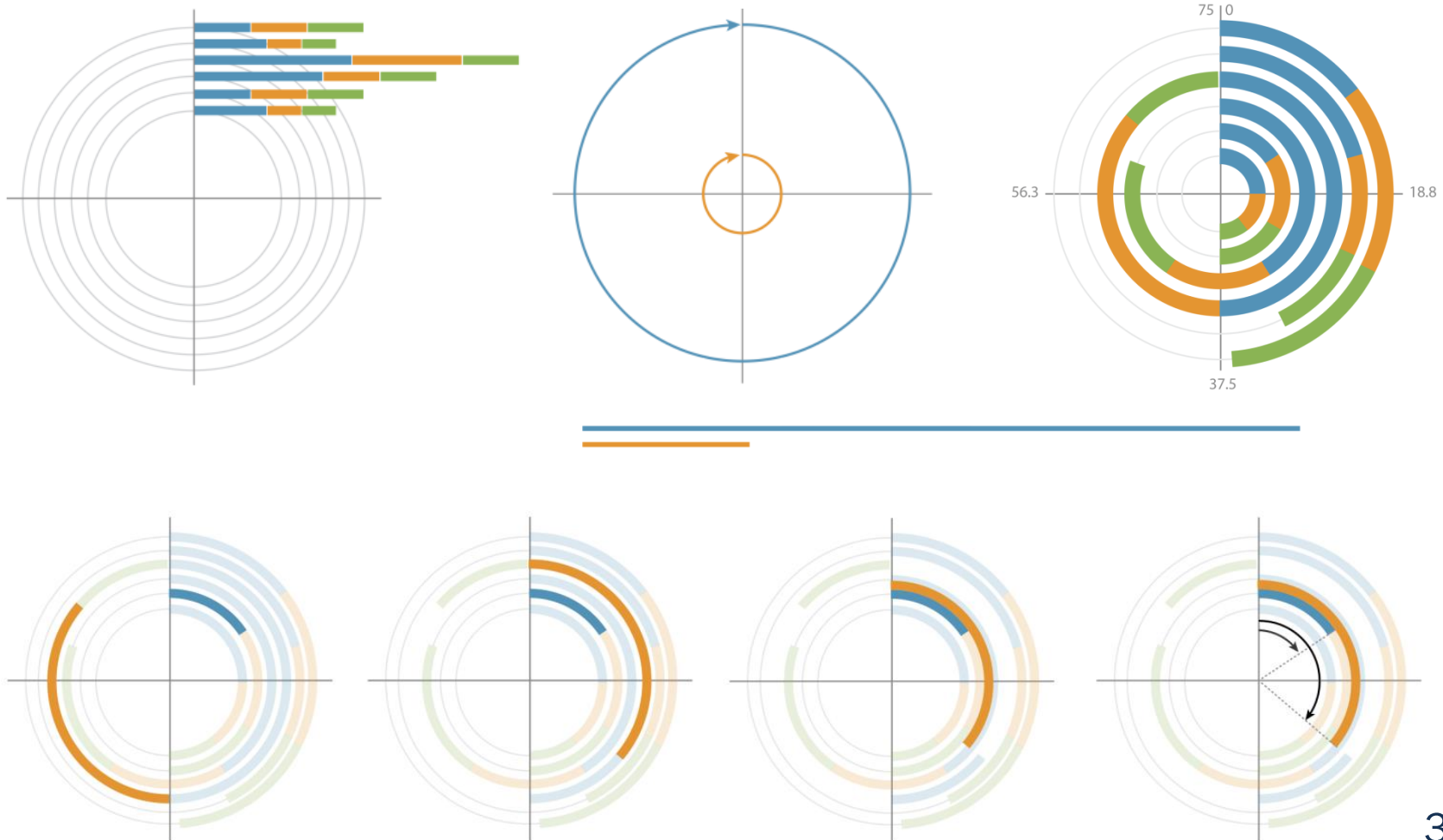
Compare Heights

- of bars
- of stacks
- of series

Compare proportions

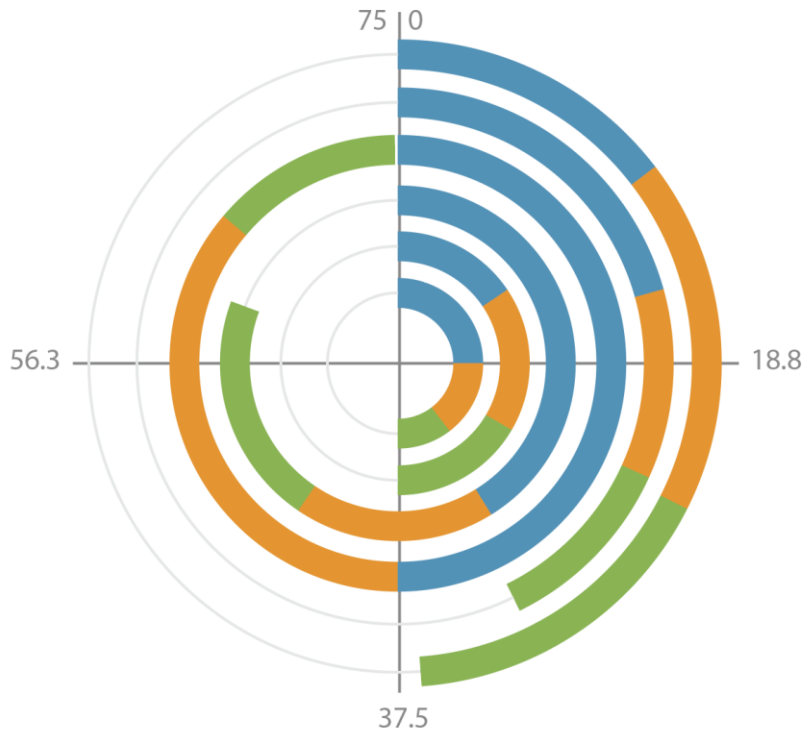
Spotlight: Racetrack Chart

The racetrack chart is a bar chart stretched around a circle

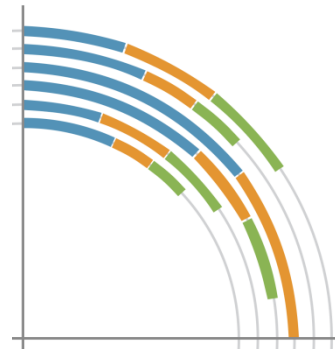


Spotlight: Racetrack Chart

Does this mean we can never use it?



Increase inner radius to reduce the difference between bars

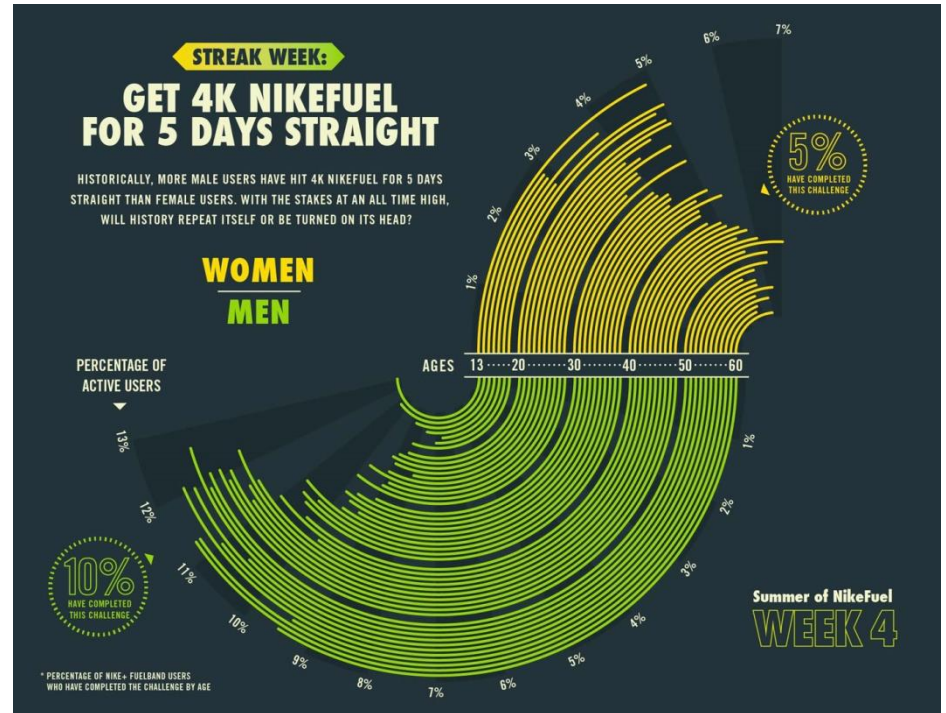
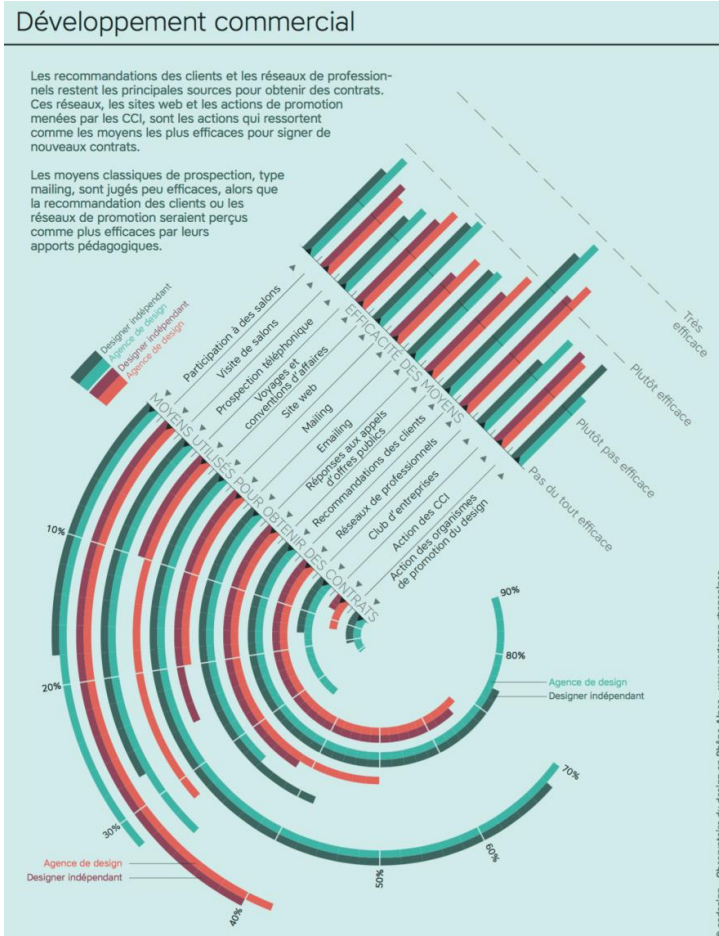


Reduce angle to minimize distortion

Use in situations where quantitative accuracy is not important

Spotlight: Racetrack Chart

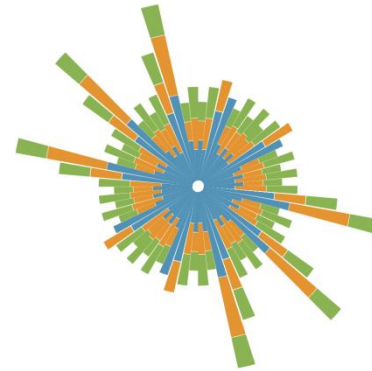
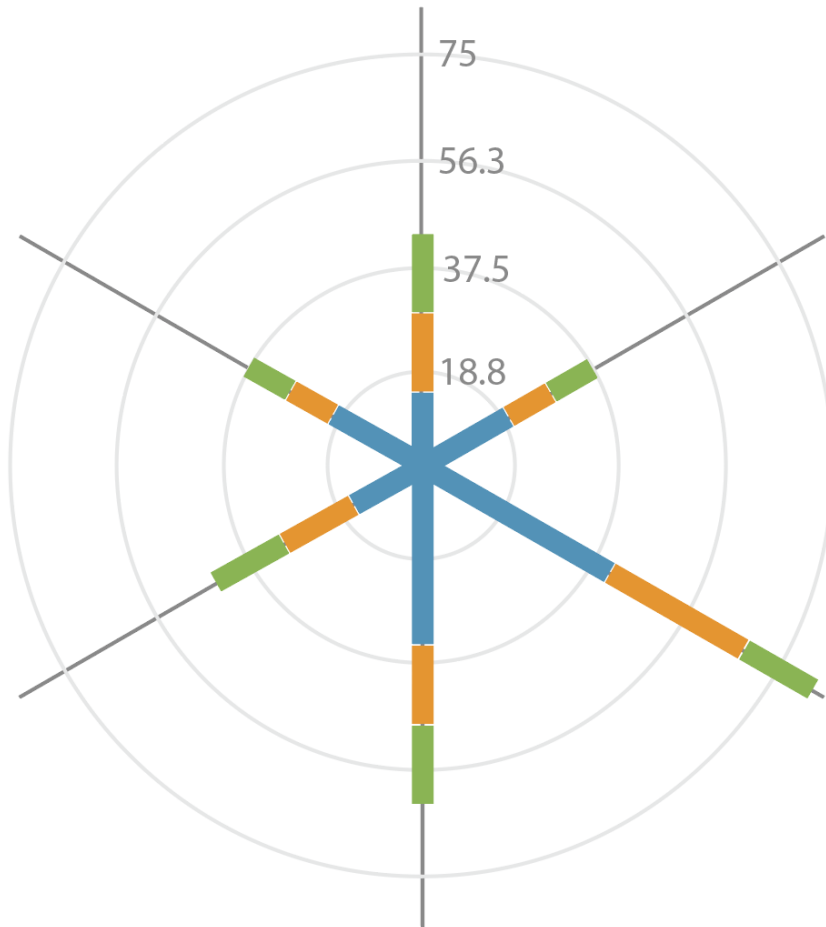
Finding the right context



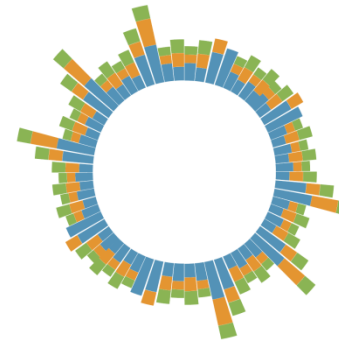
<https://www.behance.net/gallery/30961821/Nike-Fuel-Script-Seal>

Spotlight: Radial Bar Chart

The radial bar chart is a stacked bar chart rotated around a point



Lots of bars focus on trends/outliers rather than values

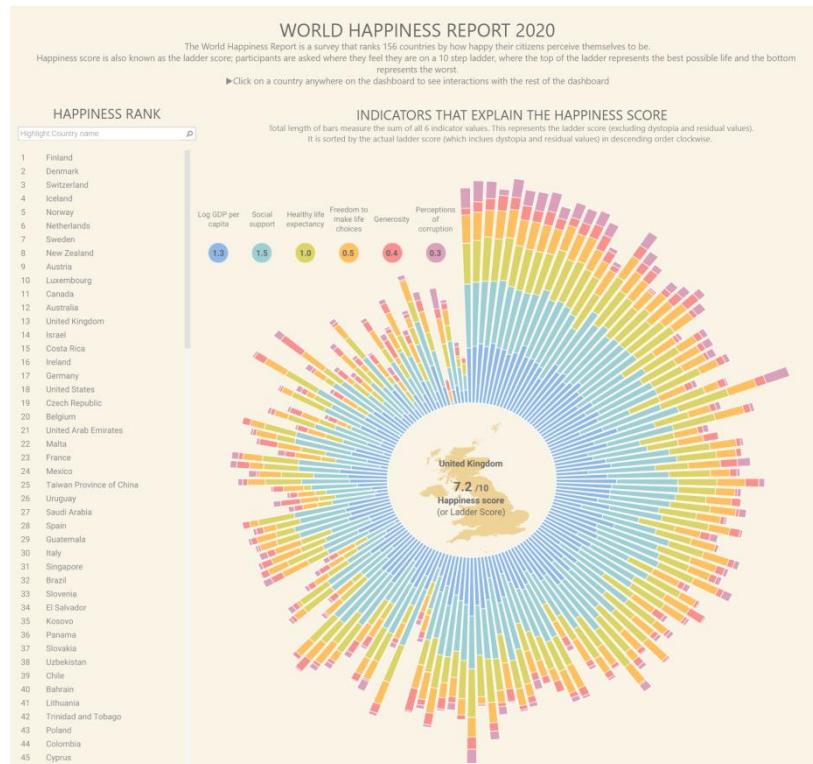


Increase inner radius to keep center series from getting lost

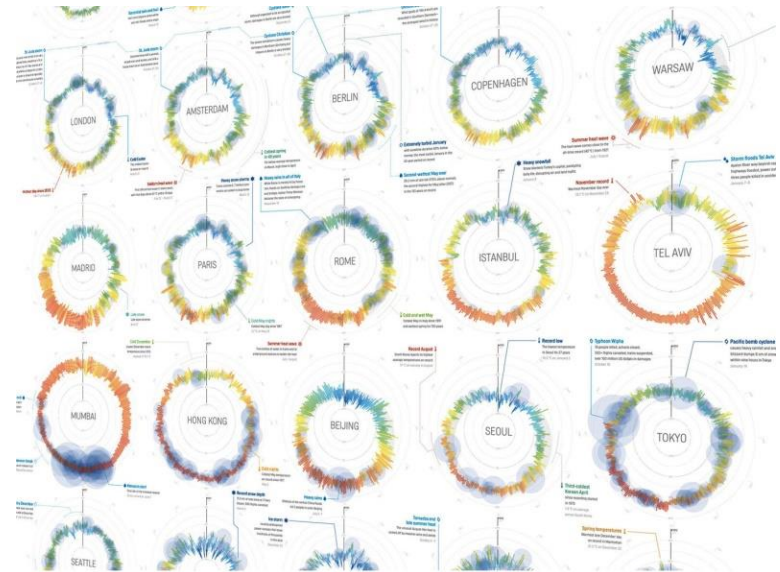
Use with cyclic data (annual cycles, etc.) when accuracy is less important

Spotlight: Radial Bar Chart

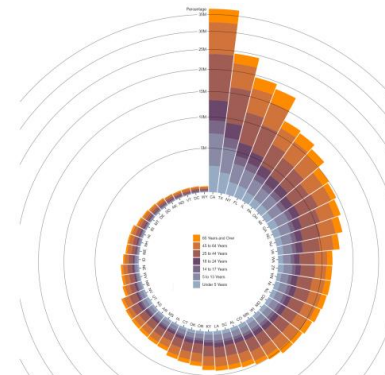
In some cases, the radial bar chart can be quite effective



<https://public.tableau.com/profile/kolsuma.aktar#!/vizhome/WorldHappinessReportMakeoverMonday2020Wk19/Dashboard1>



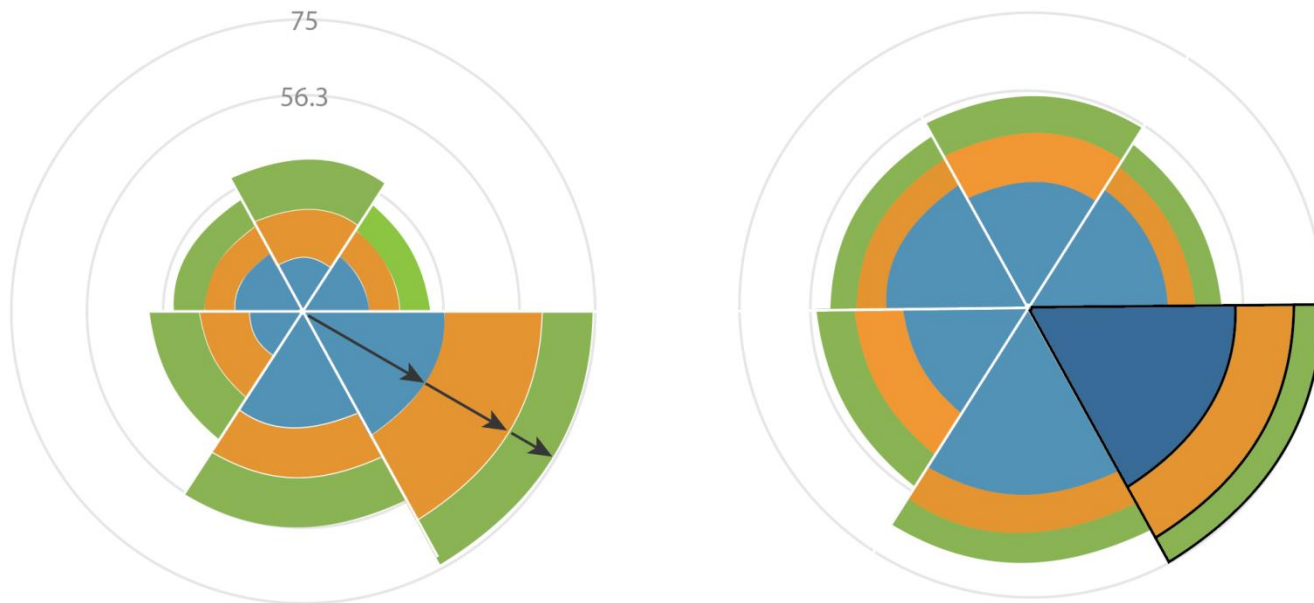
<http://www.weather-radials.com/>



<https://observablehq.com/@mkapoorisid/radial-stacked-bar-chart-ii>

Spotlight: Rose Diagram

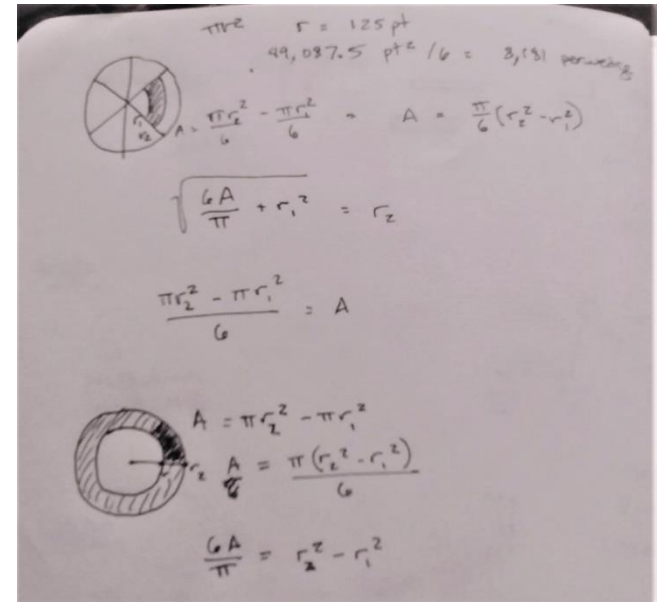
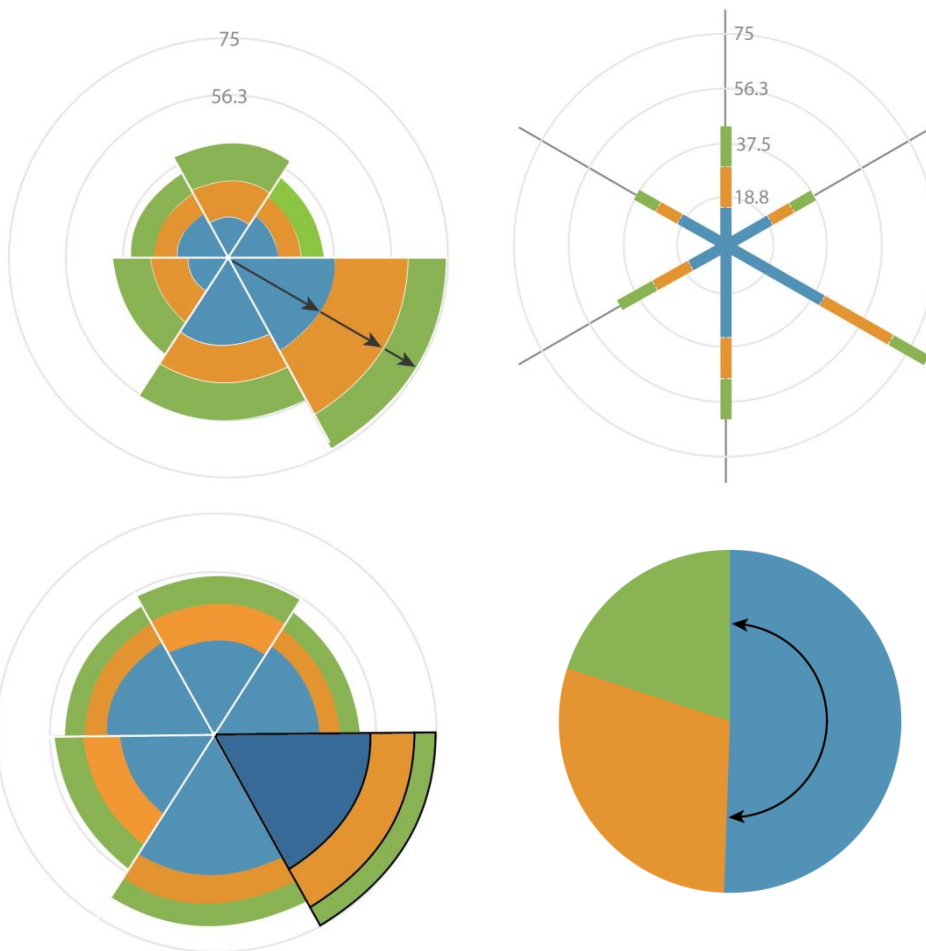
The rose diagram can be drawn as a stretched radial bar chart (length encoding), or as a stacked pie chart (area encoding)



It's hard for a user to tell how to interpret the graph: they have to guess which method you used.

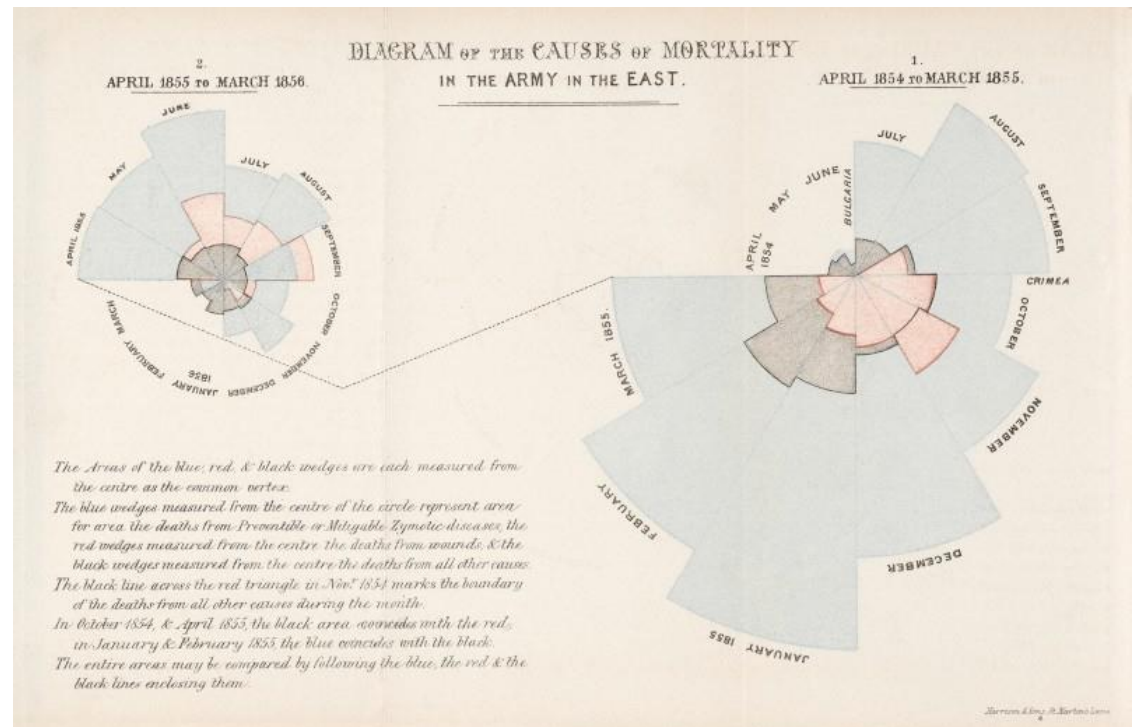
Spotlight: Rose Diagram

At first glance, the rose diagram looks like a radial bar, but it's actually much more closely related to the pie chart



Spotlight: Rose Diagram

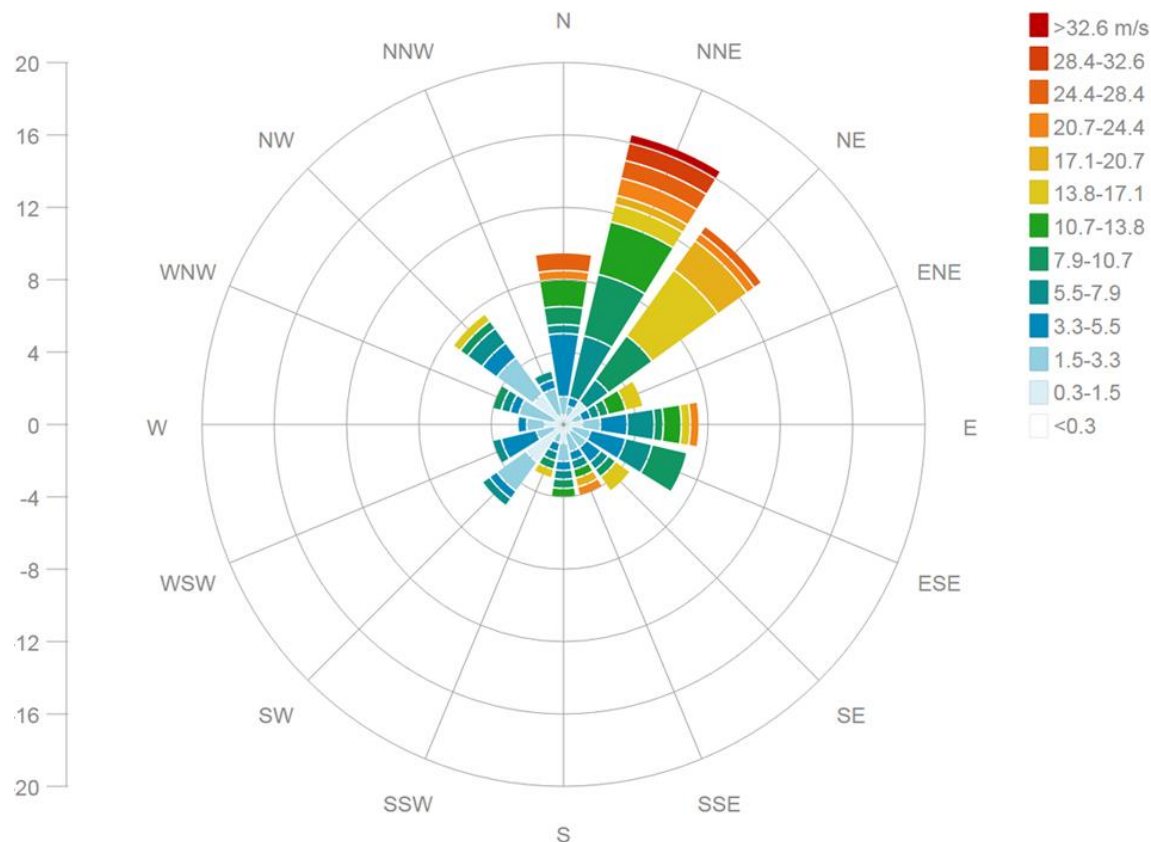
Regardless of its technical accuracy, there's no doubt that the original rose diagram was a very effective chart



This all comes back to understanding your purpose, and what you are trying to accomplish with your chart.

Spotlight: Rose Diagram

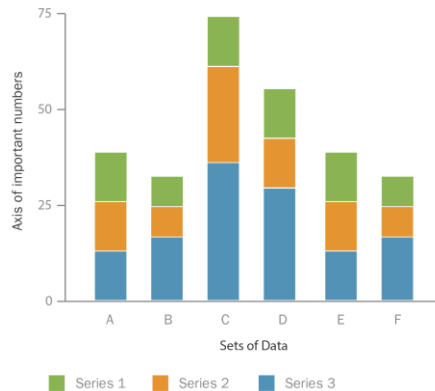
A wind rose is a related graph that maps wind speed onto direction



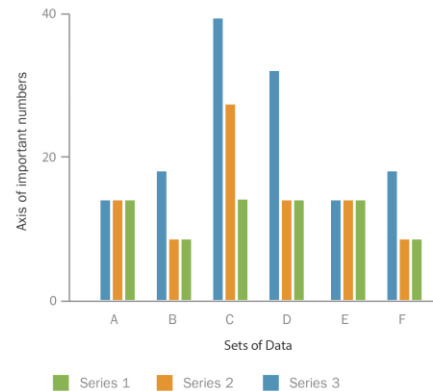
Final Selection

Which chart would you choose?

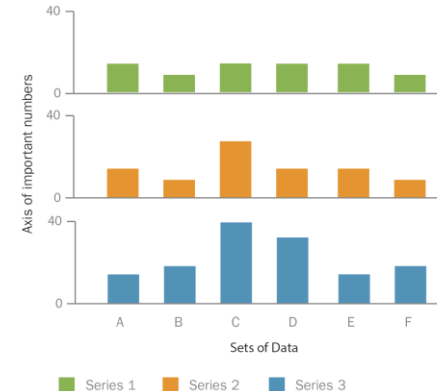
Stacked bar chart



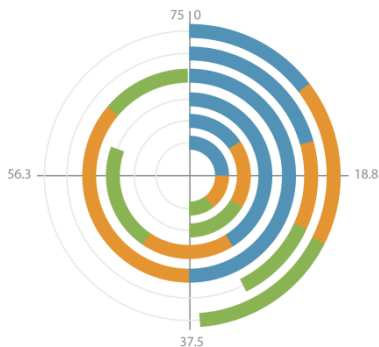
Grouped bar chart



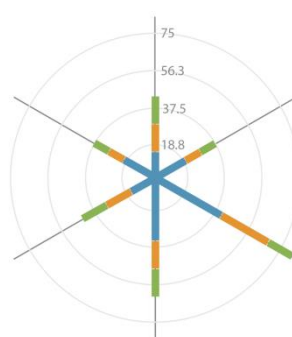
Small multiples bar charts



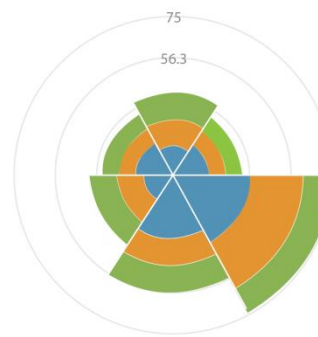
Racetrack chart



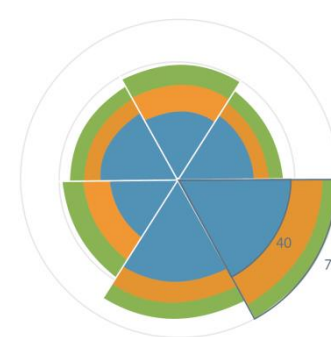
Radial bar chart



Rose diagram (length)



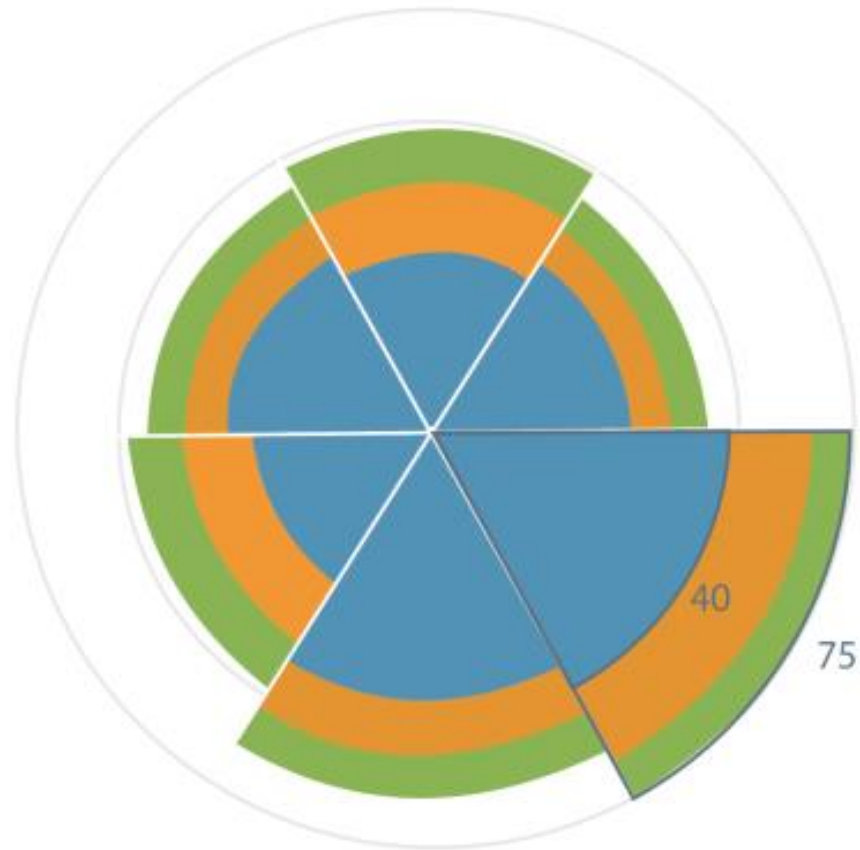
Rose diagram (area)



Leveraging Design

Basic design principles can make a complicated chart clearer

- Labels
- Animation/introduction
- Keys and legends
- Highlight important data
 - Color
 - Text/object style
 - Visual salience
- Interactions
- Dynamic annotations
- Tooltips to show values



The Bottom Line:

Ultimately, the “best chart” depends on your purpose and the user task.

Understanding that task will help you to make better data vis.

Summing up: Things to think about

- What's your **purpose**?
- **Who** is it for?
- What are you trying to **show**?
- What do people **need to see** to understand?
- What makes sense for **your data**?
- Which chart supports the **user task**?
- How can you **use design principles** to add emphasis and a unique perspective?

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