

Gulf of Alaska Common names No temperatures

Aleutian Islands Common names No temperatures

Scatter 1 Scatter 2

Pacific cod None

2013

Scatter 1 Scatter 2

Pacific cod None

2000

Loading...

Loading...

kg / hectare 5 10 15

kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



Hello!

Please find a seat. We will start at about 2:30

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19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled





Hello! I'm a data scientist, software engineer, and information designer.

Sam Pottinger

A more human-centered AI/ML

<https://gleap.org>

UC Berkeley | Data + Environment / Teaching

EVERY | Data + Synthetic Biology

IDEO | Data + Design

Plenty | Data + Indoor Agriculture

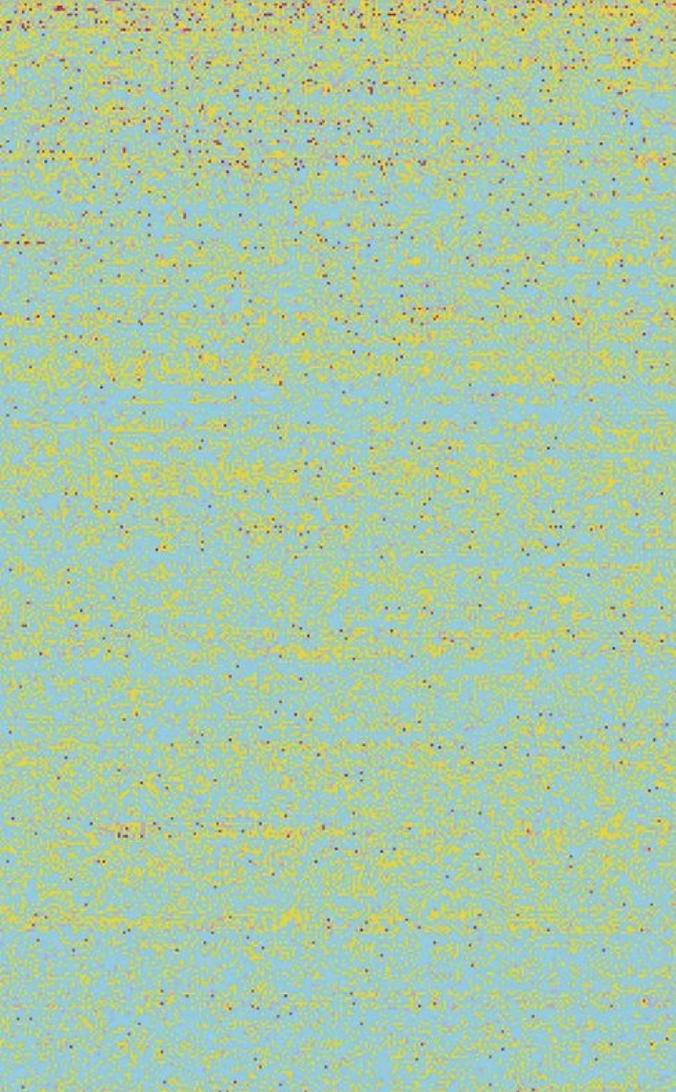
Apple | Data + Engineering

Google | Data + Visualization

LabJack | Data + Hardware

Processing | Data + Love in Java

Sketchingpy | Data + Love in Python



Hello! I'm a data visualization designer and developer.

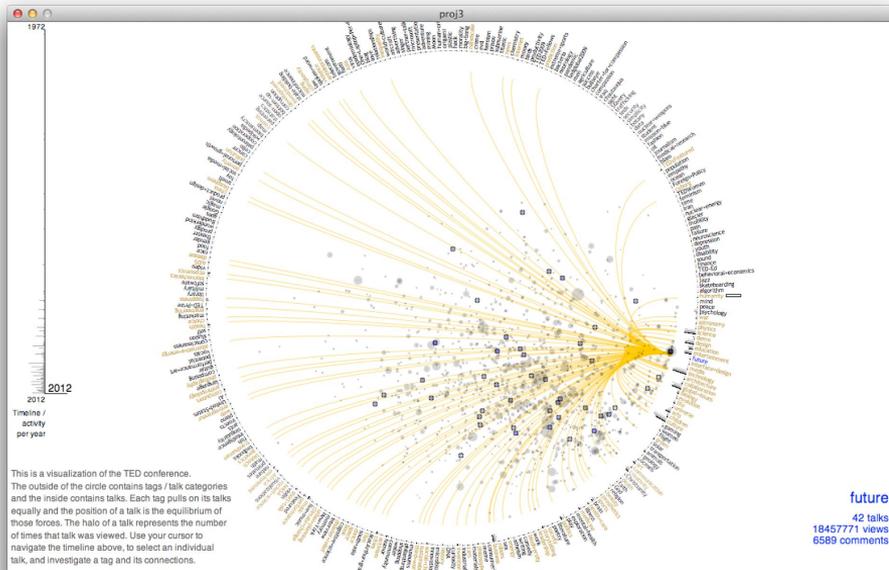
Amanda Anderson-You

amandersonyou.com

Current: **UC Berkeley** Data Visualization Specialist

Previously: Freelance | Healthcare, Philanthropy, Environment

MS in Data Visualization from Parsons School of Design



Today

Why care about visualization

How to design data visualizations

How to think about data visualization

How to continue your journey

Gulf of Alaska Common names No temperatures

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2013 None

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Aleutian Islands Common names No temperatures

Scatter 1 Scatter 2

Pacific cod Pacific cod

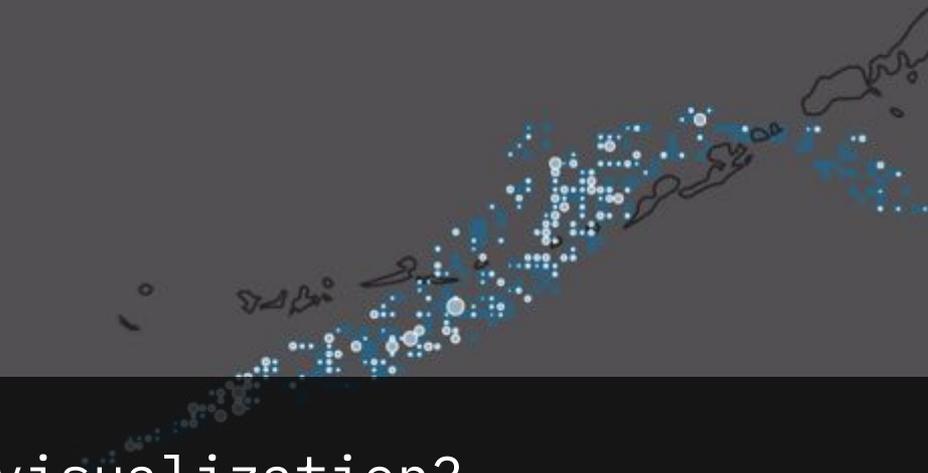
2000 None

Loading...

kg / hectare 5 10 15

22.18 kg/hectare overall CPUE

Dynamic scaling enabled



Why care about visualization?

Year	Number of Wolves	Number of Moose
1980	50	664
1982	14	700
1984	24	811
1986	20	1025
1988	12	1653
1990	15	1216
1992	12	1600
1994	15	1800
1996	22	1200
1998	14	700
2000	29	850
2002	17	1000
2004	29	750
2006	30	385
2008	23	650
2010	19	510
2012	9	750
2014	9	1050
2016	2	1300
2018	2	1500

Premise: The human visual system is good at spotting patterns.

What year saw the most moose?

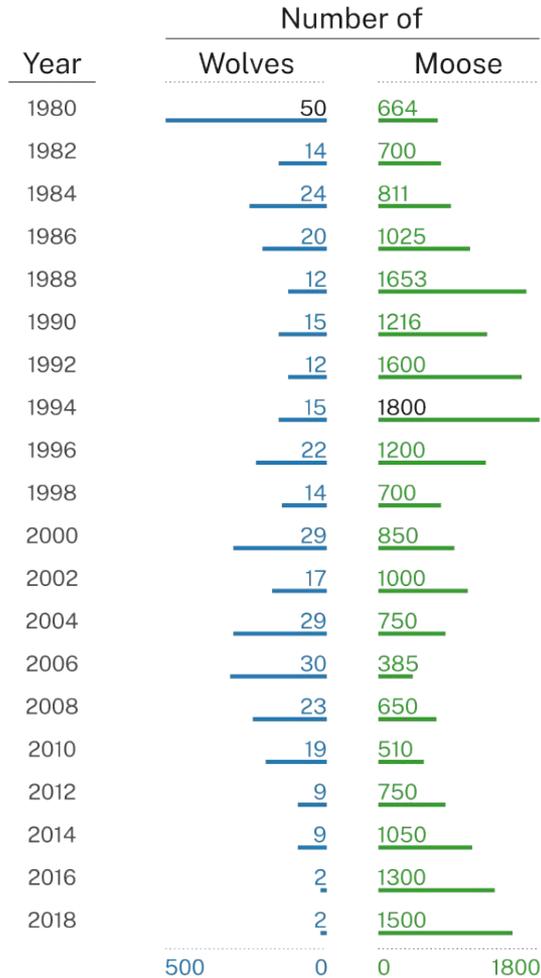
 Raise your hand when you have it.

Year	Number of Wolves	Number of Moose
1980	50	664
1982	14	700
1984	24	811
1986	20	1025
1988	12	1653
1990	15	1216
1992	12	1600
1994	15	1800
1996	22	1200
1998	14	700
2000	29	850
2002	17	1000
2004	29	750
2006	30	385
2008	23	650
2010	19	510
2012	9	750
2014	9	1050
2016	2	1300
2018	2	1500

Premise: The human visual system is good at spotting patterns.

What year saw the most wolves?

 Raise your hand when you have it.



Premise: The human visual system is good at spotting patterns.

What is the relationship between wolves and moose in Isle Royale?

 Raise your hand when you have it.

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Dynamic scaling enabled

Dynamic scaling enabled



How to design visualizations

Cleveland and McGill

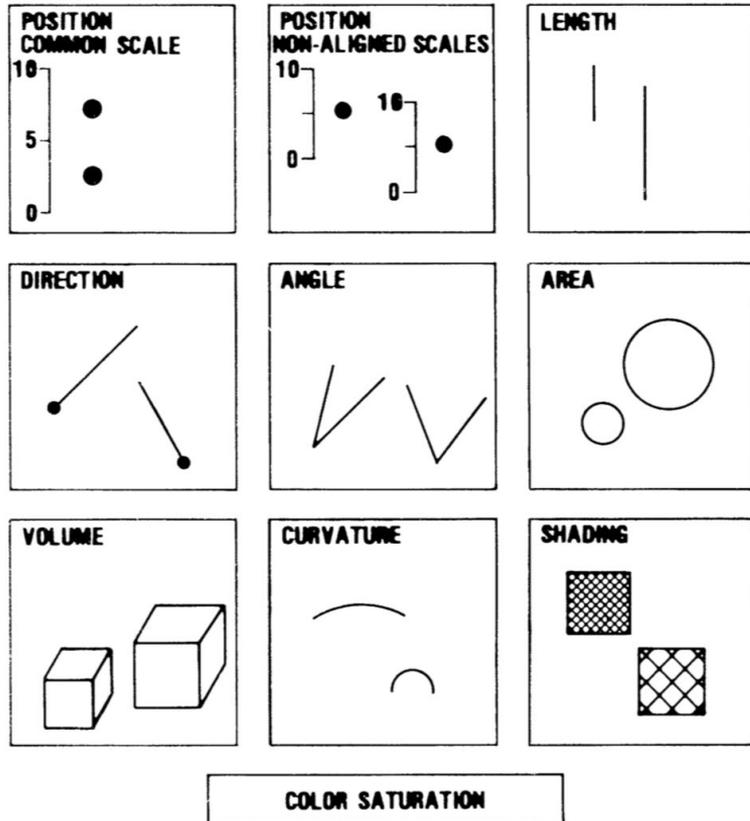


Figure 1. Elementary perceptual tasks.

Evolution gives us preattentive features.

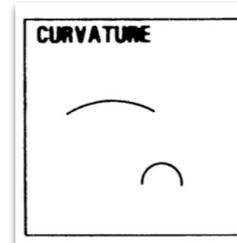
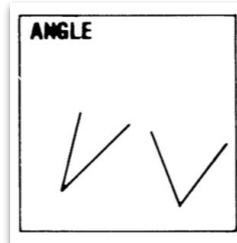
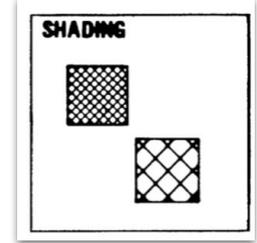
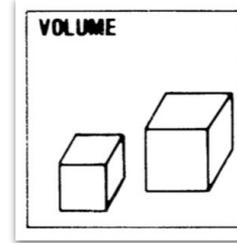
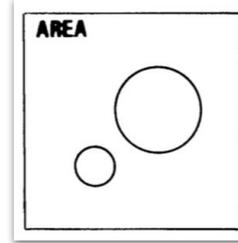
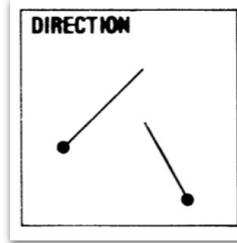
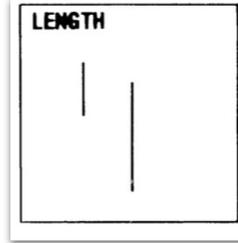
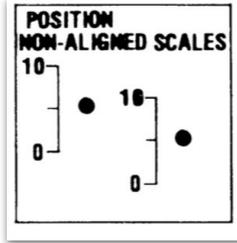
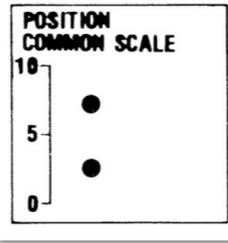
However, what is the right design of using those features?

Presenting on Cleveland and McGill in addition to some work that came after as cited.

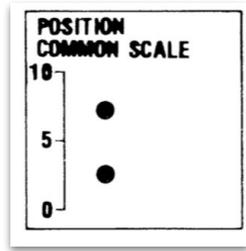
Fairly robust hierarchy

Higher Accuracy

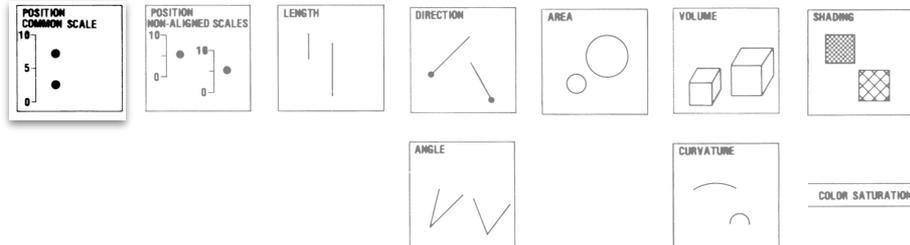
Lower or Inconsistent



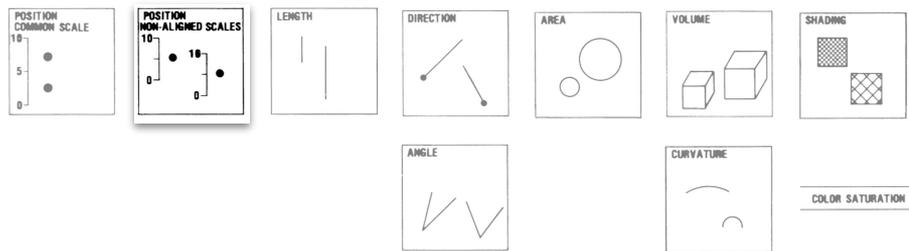
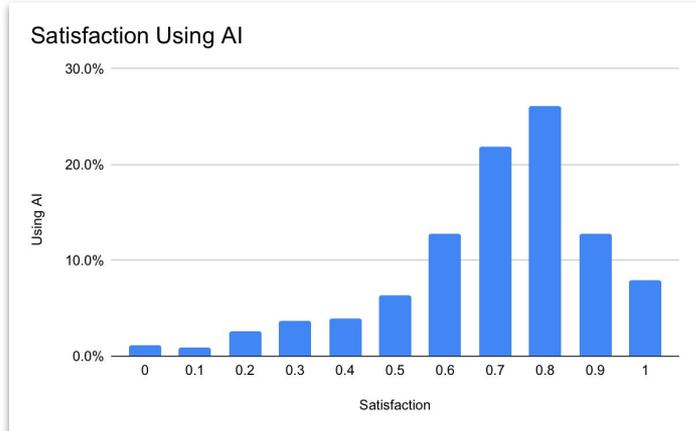
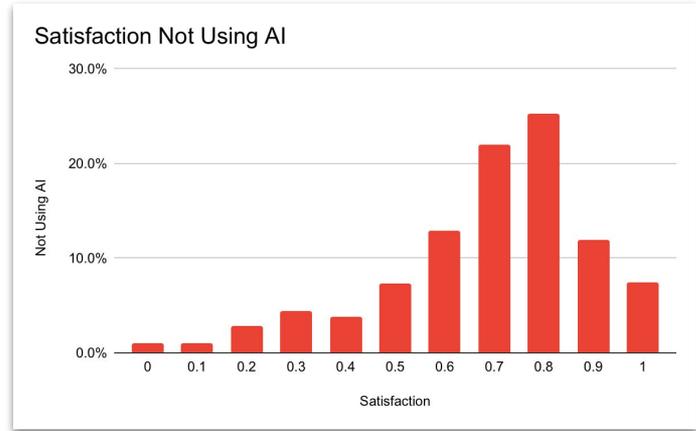
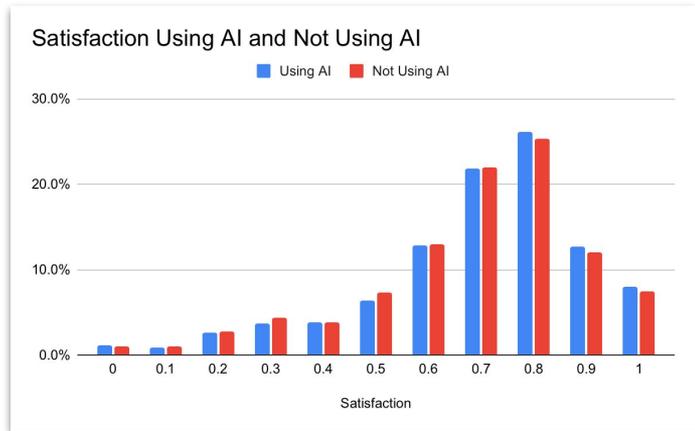
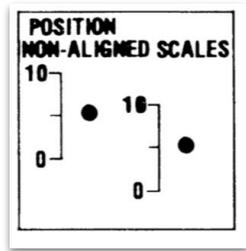
Fairly robust hierarchy



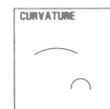
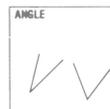
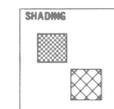
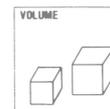
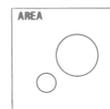
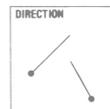
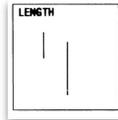
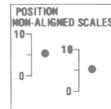
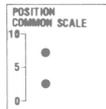
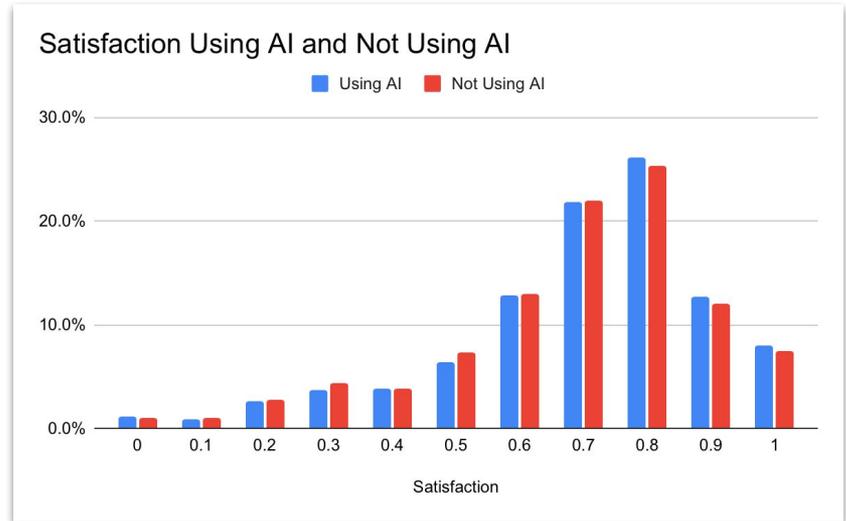
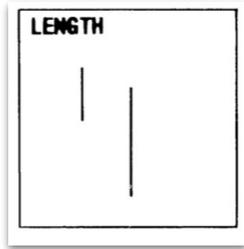
The highest accuracy encoding device is potentially not surprising as it underpins common patterns like scatter plots.



Fairly robust hierarchy

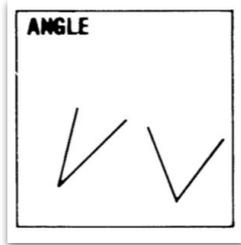
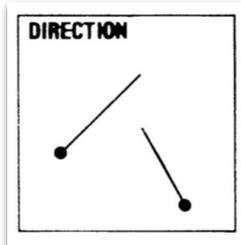


Fairly robust hierarchy



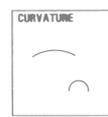
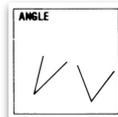
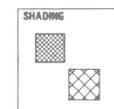
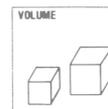
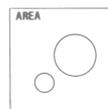
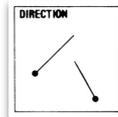
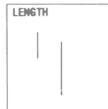
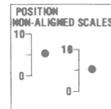
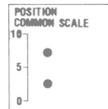
COLOR SATURATION

Fairly robust hierarchy

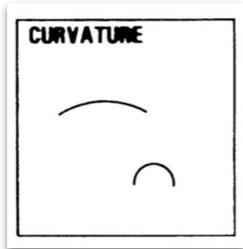
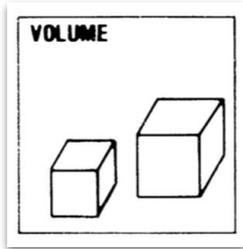
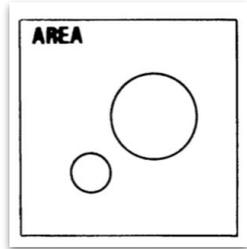


I am placing length higher than direction (slope) and angle because of consistency. There's evidence that we do better with angle closer to cardinal directions.

This is why pie charts may perform relatively poorly. Length typically has an easy fix: align against a common axis.



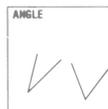
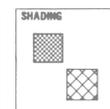
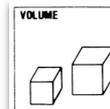
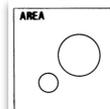
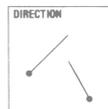
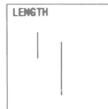
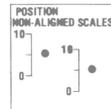
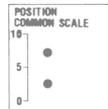
Fairly robust hierarchy



Volume generally goes poorly. This may be partially due to 3D representation within 2D media.

In general, area is good for less important “contextualizing” metrics.

Area has an issue: area vs radius.



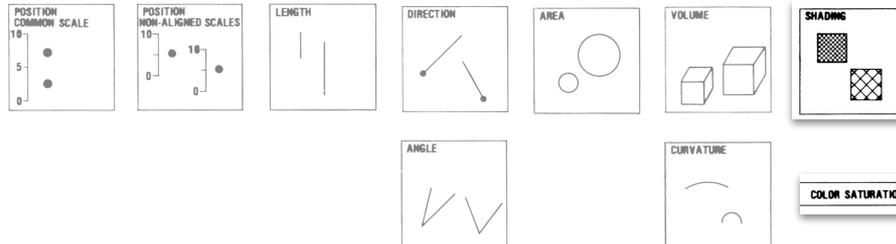
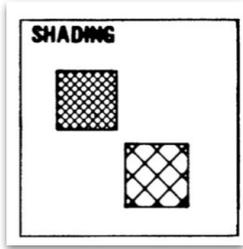
Fairly robust hierarchy

Color is fairly unreliable. It is often better for branding or complementing a message through emotion and aesthetic than it is for conveying quantitative information.

It may still serve a purpose for a limited number of qualitative groups.

Lightness generally better than hue.

Accessibility issues: readability and color-blindness.



Group Activity



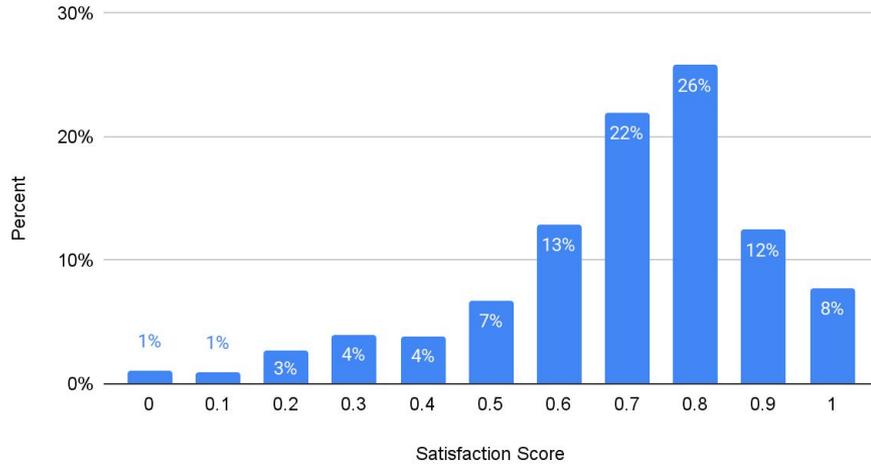
Which graphic is more likely to be read accurately?



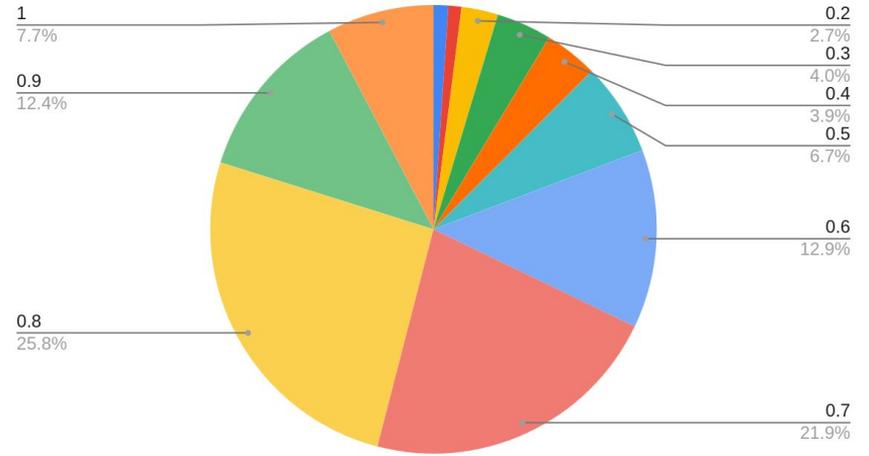
[https://
interactivedatascience
.courses
/stat159.pdf](https://interactivedatascience.courses/stat159.pdf)

Which one is more likely to be successful?

Satisfaction Score Frequency

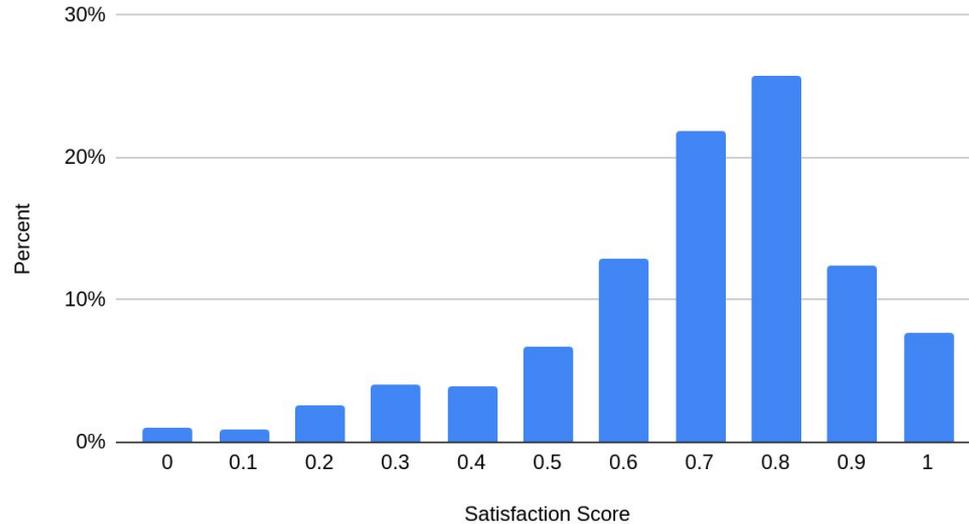


Satisfaction Score Frequency



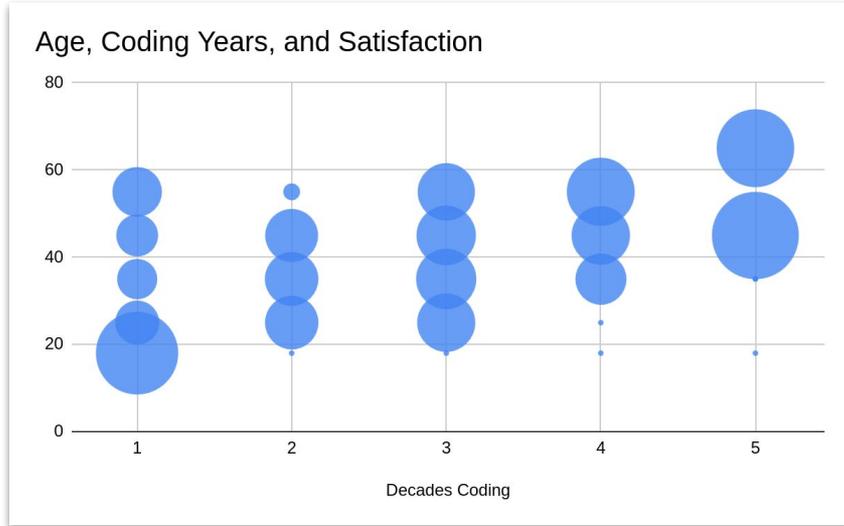
Which one is more likely to be successful?

Satisfaction Score Frequency



Satisfaction Score	Percent
0	
0.1	
0.2	
0.3	
0.4	
0.5	
0.6	
0.7	
0.8	
0.9	
1	

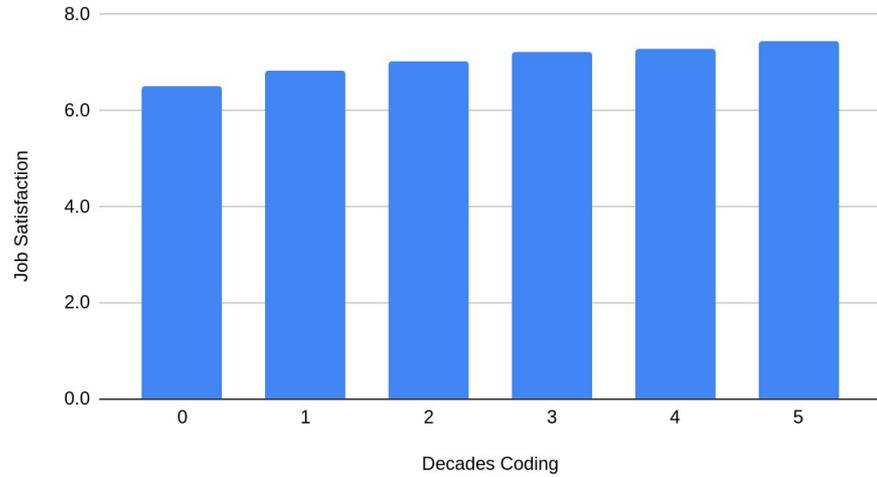
Which one is more likely to be successful?



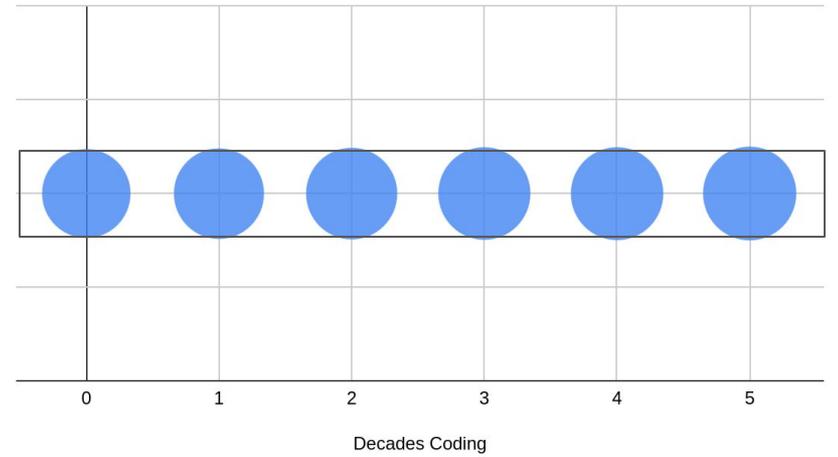
		Decades Coding				
		1	2	3	4	5
Age Group	65					1
	55	1	1	1	1	
	45	1	1	1	1	1
	35	1	1	1	1	
	25	1	1	1		
	18	1				

Which one is more likely to be successful?

Job Satisfaction vs. Decades Coding



Job Satisfaction vs. Decades Coding



Pause here

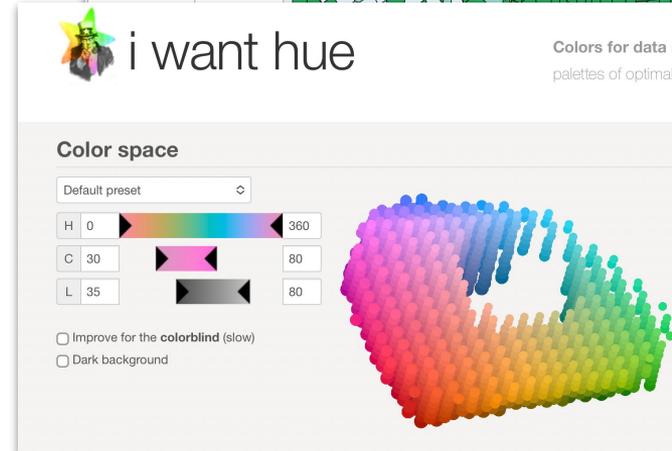
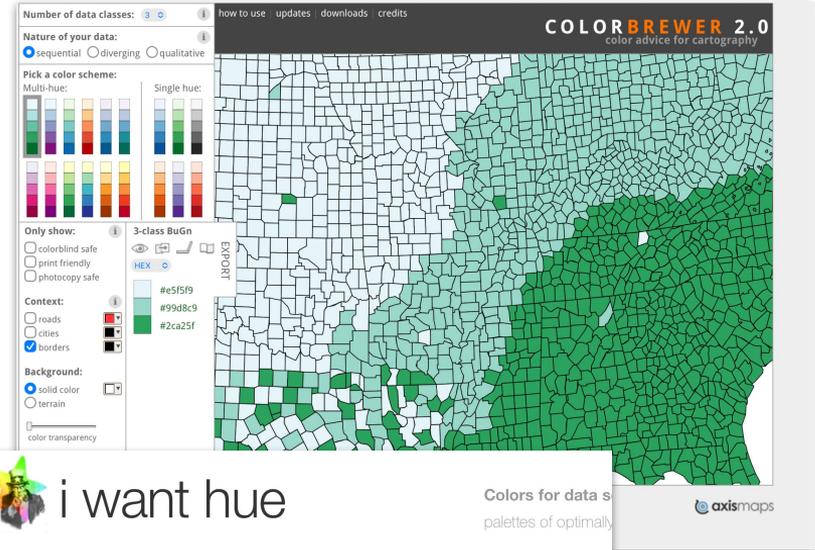


If you got here, you did great! Please wait and we will reconvene as a group!

Color and Contrast

Consider not using color as an encoding device and, instead, leave it for **aesthetic and branding**.

Color is contextual. It depends on the background and can be influenced by glyphs nearby.

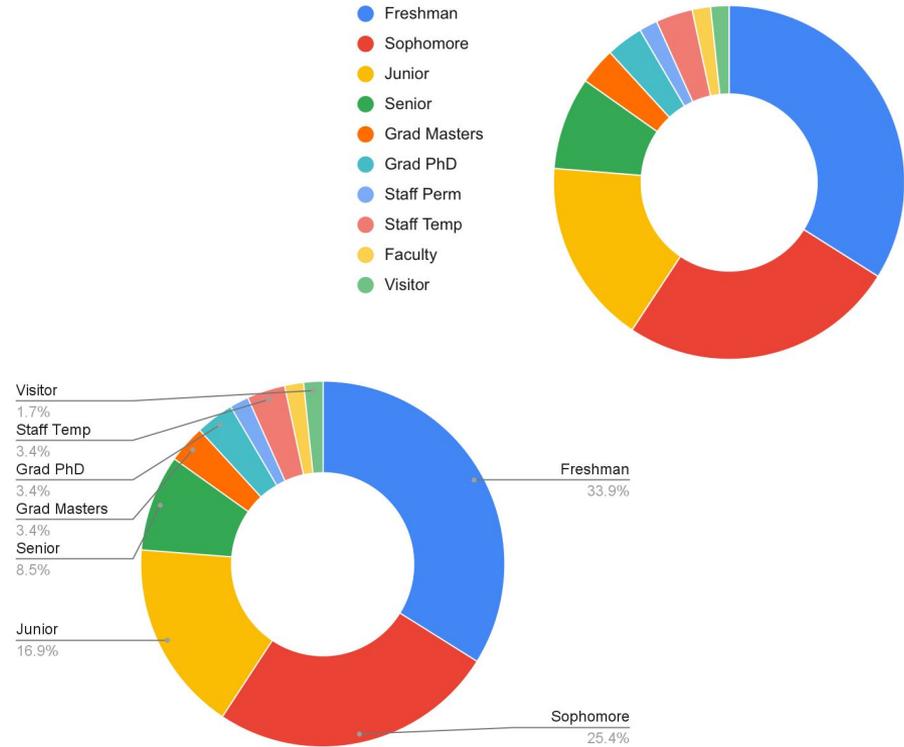


Color and Contrast

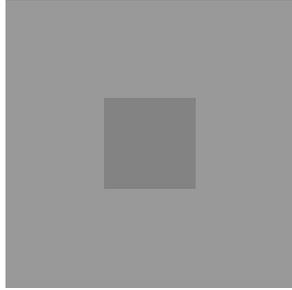
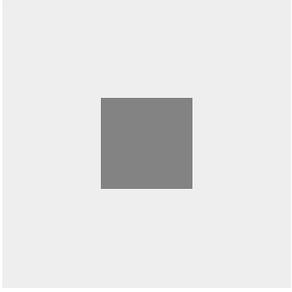
If color is needed for **quantitative scales**, consider just using luminance. Try using a scheme generator like ColorBrewer.

If you have to use color as a **qualitative encoding**, use ColorBrewer or I Want Hue. We only get about 6 colors reliably. An alternative is direct labeling.

When possible, **double encode** so the graphic still works without color.



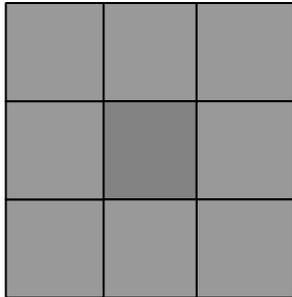
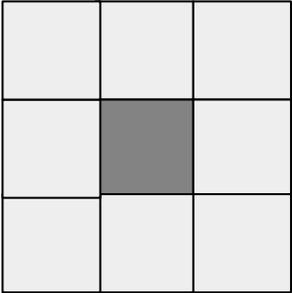
Color and Contrast



If reliable reading of figure is required, ensure **sufficient contrast** to background.

What we see depends on what is around it.

We can create borders or consistent background to emphasize absolute value extraction.

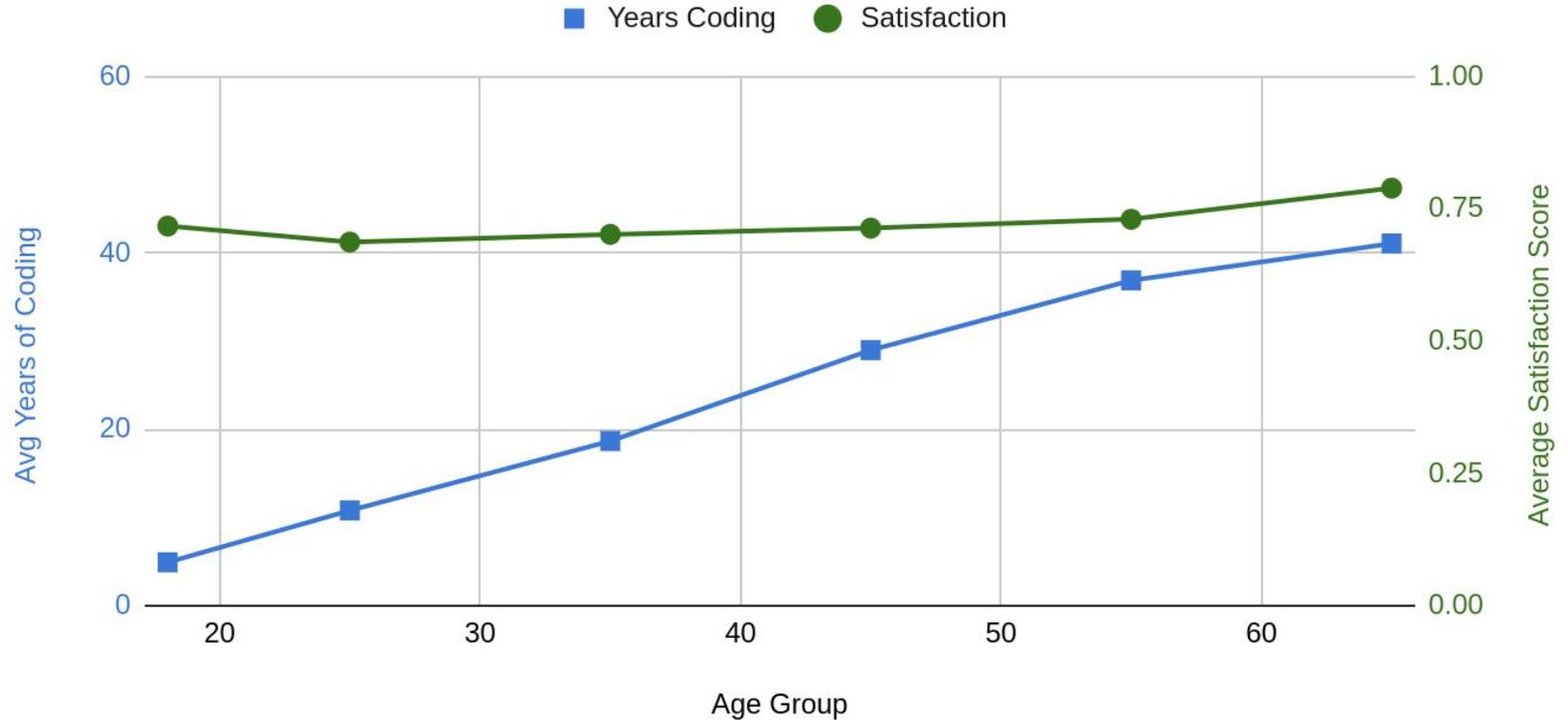


Visual processing is fast, memory is limited.

Shared axes, dual axes, and direct labeling.

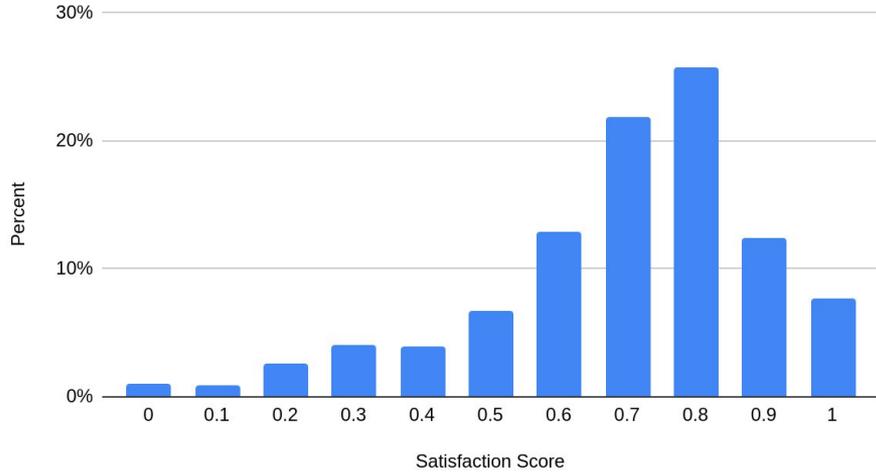
Dual Axes

Age vs Years of Coding and Satisfaction

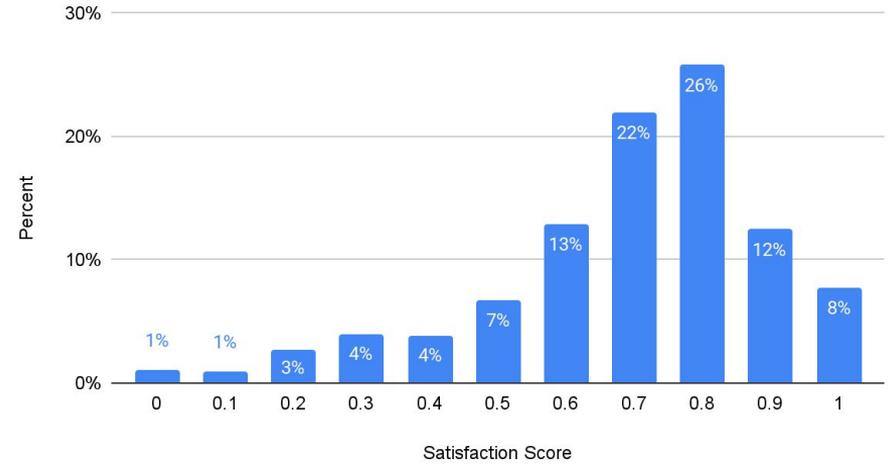


Direct Labeling

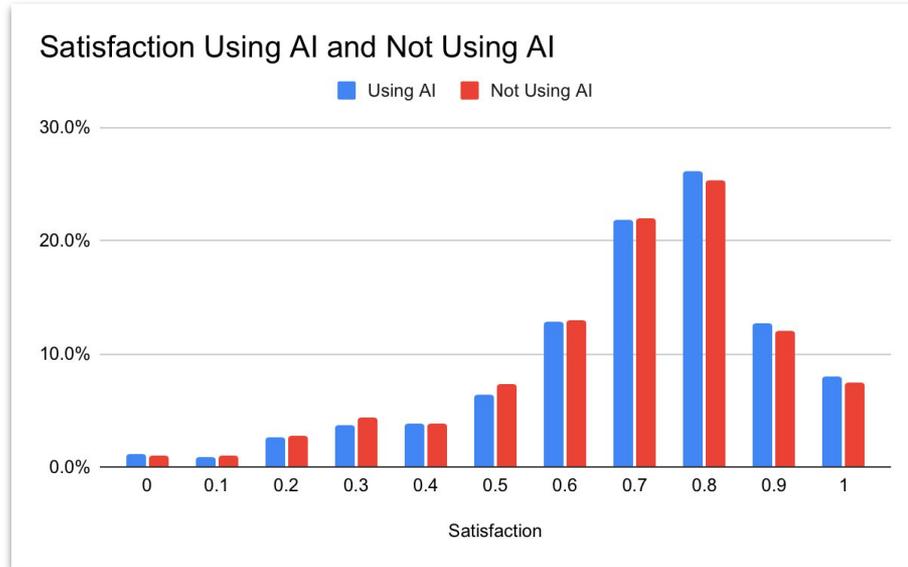
Satisfaction Score Frequency



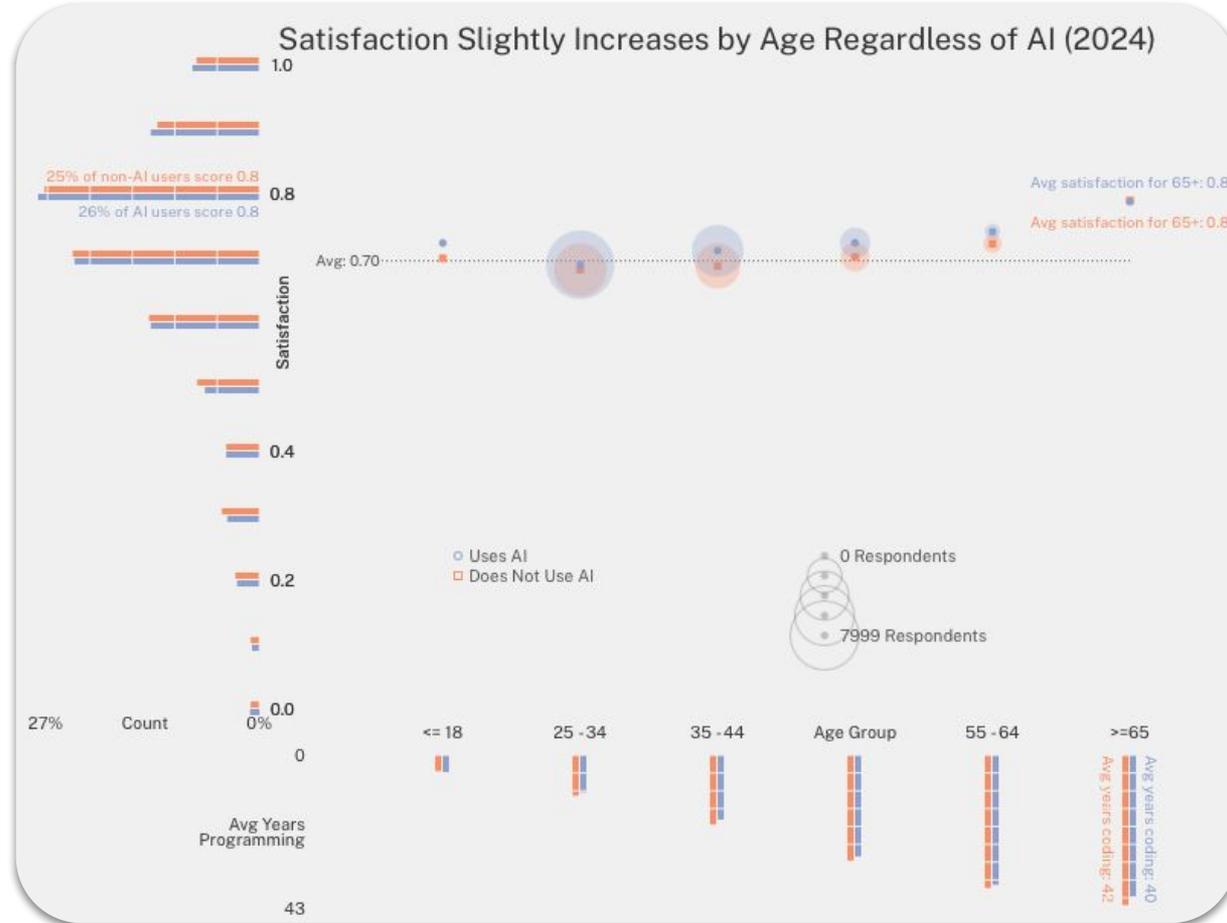
Satisfaction Score Frequency



Keeping channels clear



Tie it together



See also Gestalt Principles...

Gulf of Alaska Common names No temperatures

Aleutian Islands Common names No temperatures

Scatter 1 Scatter 2

Pacific cod None

2013

Scatter 1 Scatter 2

Pacific cod None

2000

Loading...

Loading...

kg / hectare

kg / hectare

19.77 kg/hectare overall CPUE

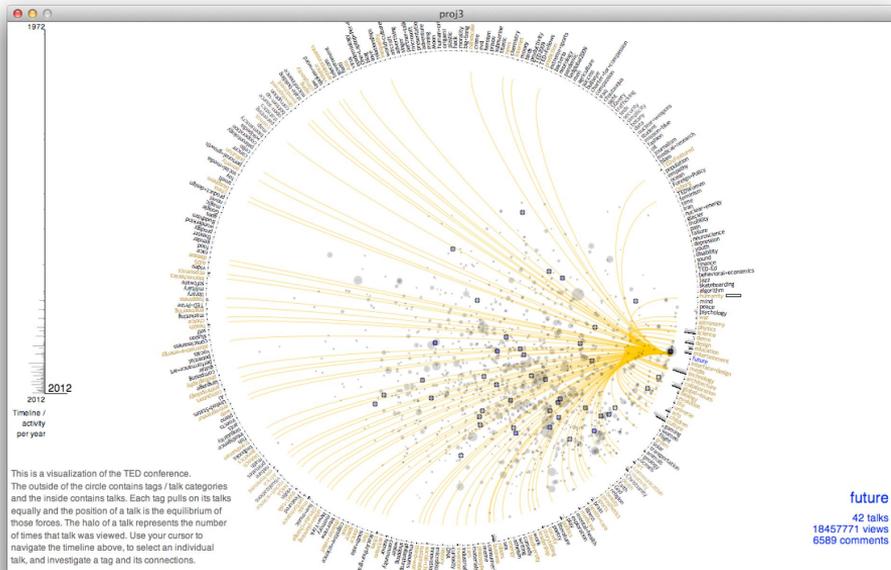
22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



<Break>



Today

Why care about visualization

Human visual system allows for visual reasoning and more efficient interpretation of data.

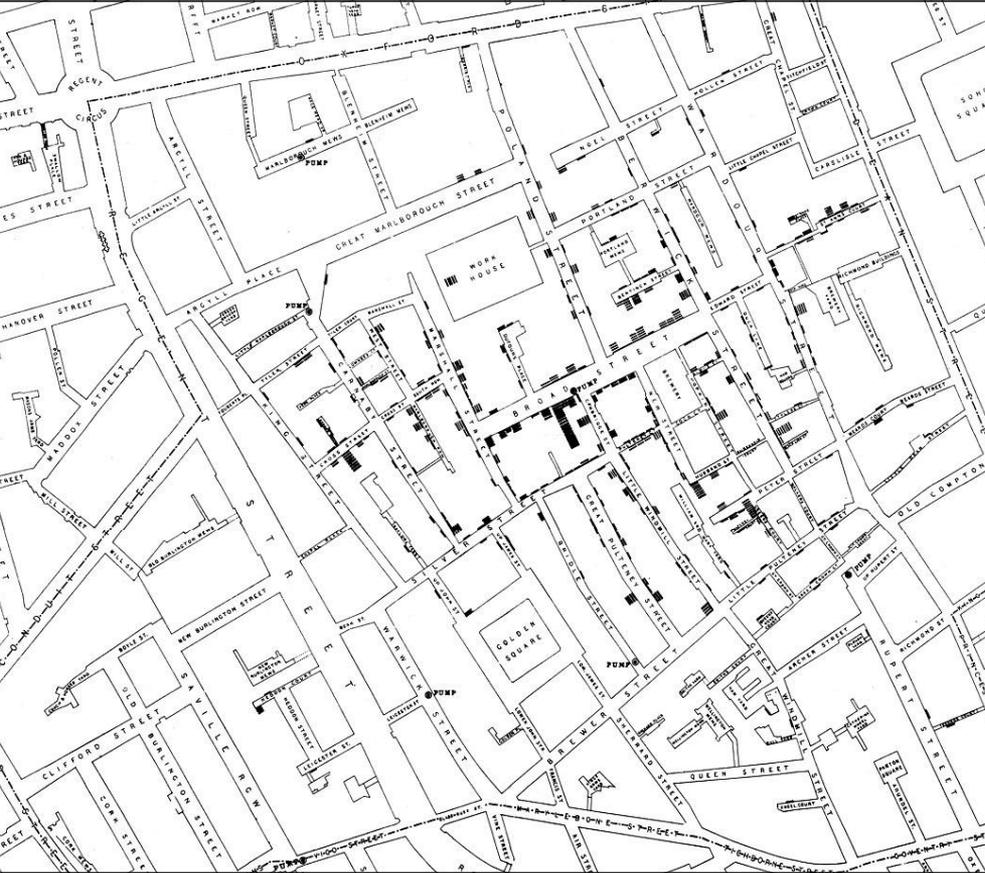
How to design data visualizations

Encoding devices, careful use of color, patterns for higher density graphics.

> How to think about data visualization

How to continue your journey

How can data become visible?



Data -> Graphic

4 Perspectives

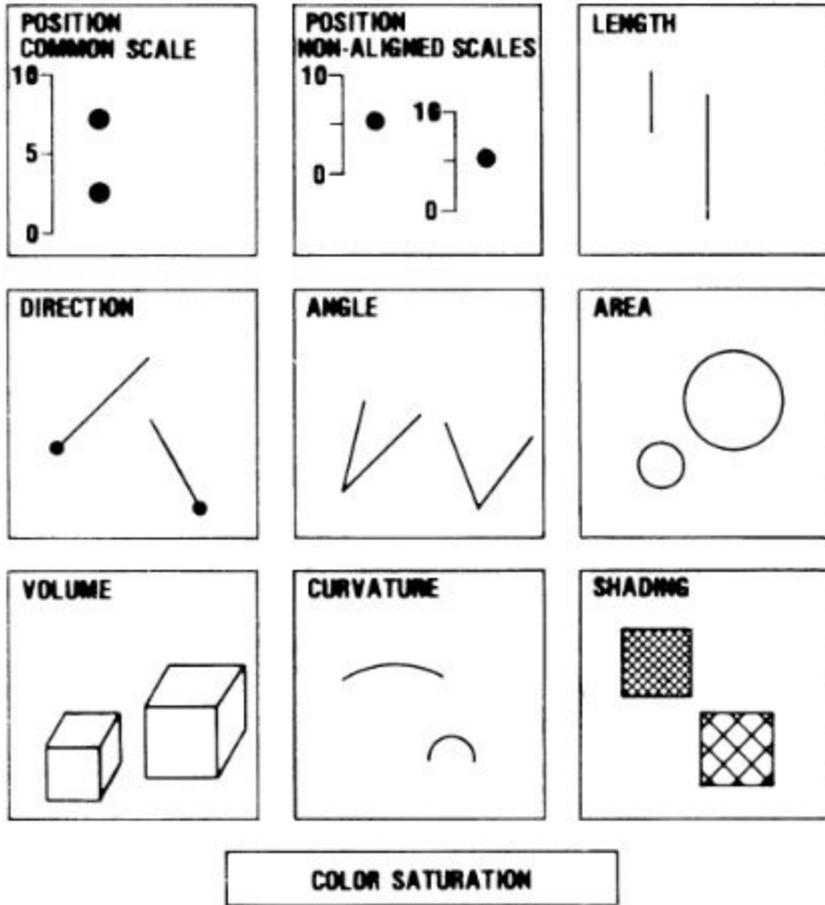
| As representation

As task

As message

As dialogue

Why and how different groups do data visualization. How you can think about it in your work.



Example: This first way of thinking about data visualization focuses on encoding.

How do we “map” attributes of data to visual attributes?

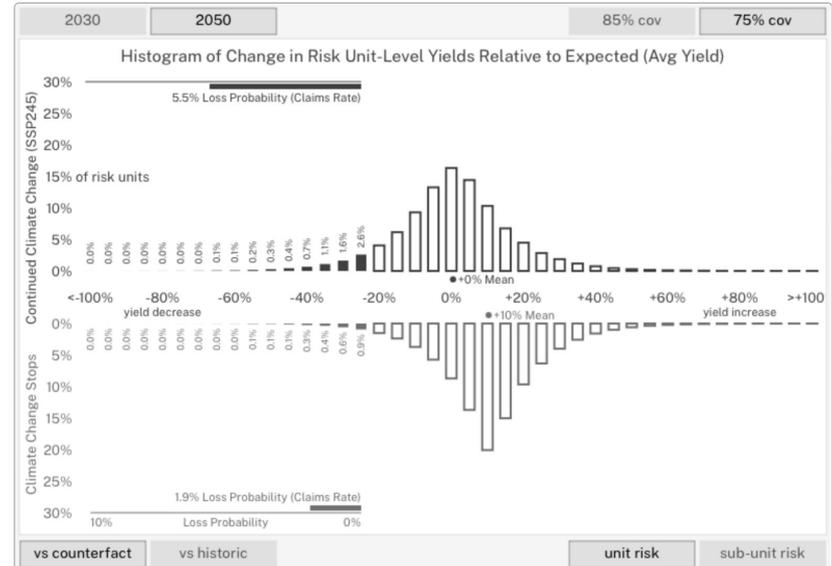
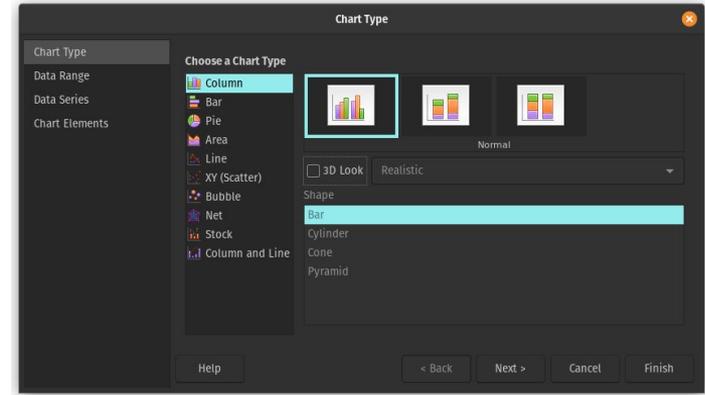
What visual encodings are better than others?

How do we make visualizations accessible?

Figure 1. Elementary perceptual tasks.

Offers: Flexibility beyond the chart wizard but principles to guide us.

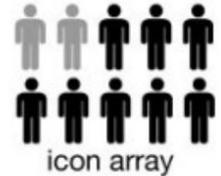
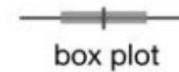
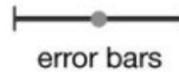
Gives us the basic building blocks for how humans process visual information but lets us use that understanding in many different ways.



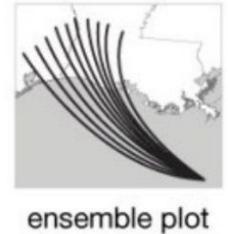
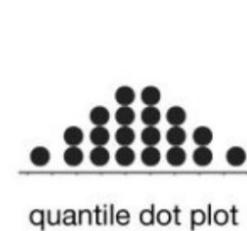
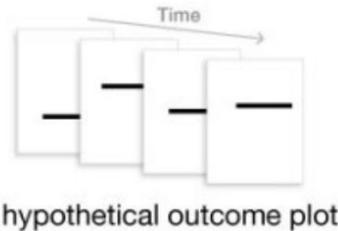
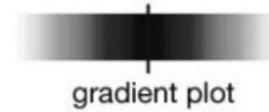
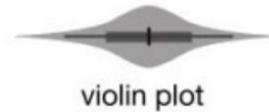
Where does uncertainty in visualization come from?

- **Data:** random errors or missing entries
- **Assumptions:** model assumptions provide plausible values from distributions
- **Models:** choice over techniques and models we use
- **Replications:** variations from study to study and synthesizing

Intervals and Ratios



Distributions



How can users ask questions of data?

4 Perspectives

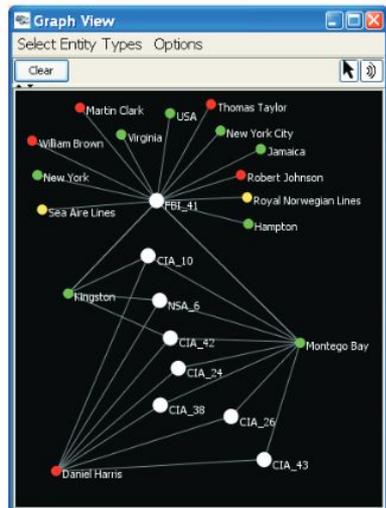
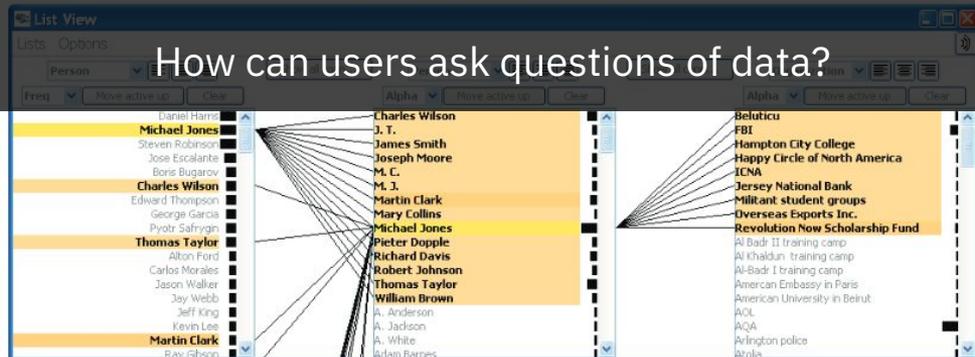
As representation

| As task

As message

As dialogue

Why and how different groups do data visualization. How you can think about it in your work.



Data > Graphic -> User

Premise: Visualizations
are part of a broader user
journey.

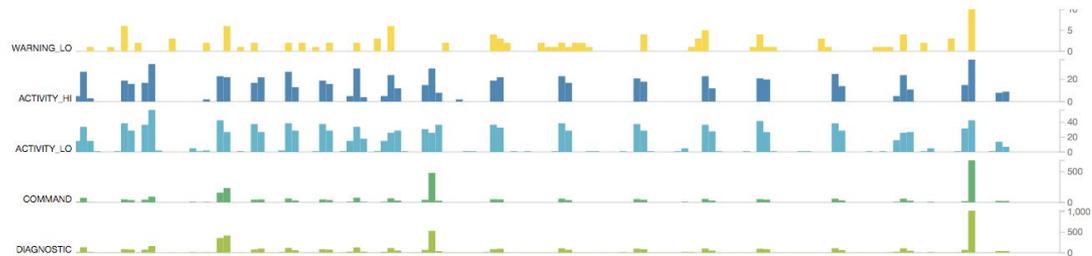
A structured way to think about the user
in the context of data visualization.

SET A SCET TIME RANGE (FROM END): **LAST 24 HOURS** LAST 48 HOURS LAST WEEK CUSTOM

START: 2016-012T21:13:58.459 END: 2016-013T21:13:58

▼ EVR COUNTS *Click on a bar or brush the graph to select a time range for EVRs, displayed in the table below.*

FILTER EVR LEVELS: LEGEND: Each bar represents 10 minutes of EVR data.



▼ EVR TABLE *Click on a row to save an EVR to your EVR collection below.*

FILTER EVRS:

Level	Name	Task	Message	SCET ▼
ACTIVITY_LO	DWN_EVR_MANAGE_PACKET_BUFFER_GATE	dwn	Pktbuf (PB_RECORDERD_DP) enabled status updated to CLOSED.	2016-013T19:57:15.034
DIAGNOSTIC	CMD_EVR_SEQ_CMD_DISPATCH	seqeng	Dispatching sequenced command: engine number=2, seconds=505987127, subseconds=917504.	2016-013T19:57:15.034
DIAGNOSTIC	CMD_EVR_SEQ_CMD_DISPATCHED	seqeng	Successfully dispatched sequenced command: seconds=505987127, subseconds=917504.	2016-013T19:57:15.034
COMMAND	SEQ_EVR_CMD_COMPLETED_SUCCESS	seqeng	Successfully completed sequenced command DMD DOWN dispatched from sequence engine number 2, command number 4142016-013T19:57:15.034	2016-013T19:57:15.034
COMMAND	SEQ_EVR_CMD_DISPATCH	seqeng	Dispatching sequenced command DMD DOWN from sequence engine number 2, from sequence file BKG_COMM_2016_013.se2016-013T19:57:15.033	2016-013T19:56:55.956
COMMAND	SEQ_EVR_CMD_COMPLETED_SUCCESS	seqeng	Successfully completed sequenced command CORRECT TIME PACKET dispatched from sequence engine number 2, command 2016-013T19:56:55.956	2016-013T19:56:55.956
ACTIVITY_HI	DWN_EVR_GENERATING_TC_PACKET	dwn	The time correlation packet was created: vcid=0, vfc=1155444, packet_time=1e28c024:e8500000, frame_time=1e28c022:f1f2c2016-013T19:56:55.956	2016-013T19:56:53.993
DIAGNOSTIC	DWN_EVR_TC_TIME_ARRIVED	dwn	The time correlation (TC) time arrived: expected=TRUE, time=1e28c022:f1f2c000.	2016-013T19:56:51.962
DIAGNOSTIC	DWN_EVR_TC_SENDING_FRAME	dwn	The time correlation (TC) reference frame was sent: vcid=0, vfc=1155444.	2016-013T19:56:51.962
DIAGNOSTIC	CMD_EVR_SEQ_CMD_DISPATCHED	seqeng	Successfully dispatched sequenced command 0xC9D3: seconds=505987103, subseconds=917504.	2016-013T19:56:51.034
DIAGNOSTIC	CMD_EVR_SEQ_CMD_DISPATCH	seqeng	Dispatching sequenced command 0xC9D3: engine number=2, seconds=505987103, subseconds=917504.	2016-013T19:56:51.034
COMMAND	SEQ_EVR_CMD_DISPATCH	seqeng	Dispatching sequenced command CORRECT TIME PACKET from sequence engine number 2, from sequence file BKG_COMM_2016-013T19:56:51.033	2016-013T19:56:23.685
COMMAND	SEQ_EVR_CMD_COMPLETED_SUCCESS	seqeng	Successfully completed sequenced command XBAND POWER dispatched from sequence engine number 2, command number 2016-013T19:56:23.685	

Example: Rachel Binx at NASA.

Looking at “event records” sent from spacecraft to NASA.

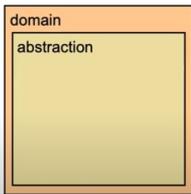
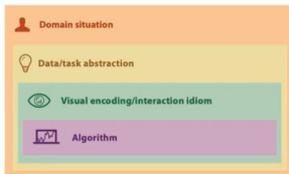
Interviewed a bunch of users to figure out how they worked with these data previously (log files).

Binx talks about how people had never seen their data before visually and the periodicity of events was revelatory for example.

Boils down into “tasks” the user executes and build user experiences to support those tasks.

From domain to abstraction

- domain characterization: details of application domain
 - group of users, target domain, their questions & data
 - varies wildly by domain
 - must be specific enough to get traction
 - domain questions/problems
 - break down into simpler abstract tasks
- abstraction: data & task
 - map *what* and *why* into generalized terms
 - identify tasks that users wish to perform, or already do
 - find data types that will support those tasks
 - possibly transform /derive if need be



Task Abstraction (Ch 3), Visualization Analysis & Design, 2021



Tamara Munzner

31.3K subscribers

Subscribe



Share



14K views 2 years ago

Task Abstraction Lecture, 2021.

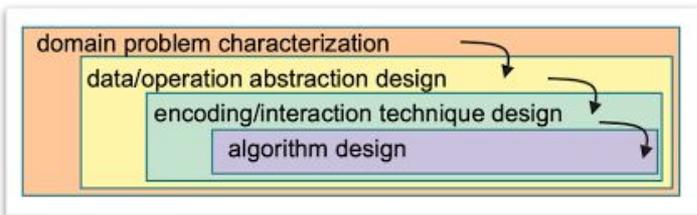
Task Abstraction (Ch 3), Visualization Analysis & Design by Tamara Munzner, CRC/Routledge 2014.

More info including editable slides and free CC-BY diagram figures on book page: <https://www.cs.ubc.ca> ...more

Offers: Structured evidence-based understanding of the user to support them in their tasks.

Orients around domains, tasks, questions, and data.

Fits within a broader modern user experience design dialogue.





11,356

PEOPLE KILLED

724 | 6%
Children under 18

AGE D

10,632 | 94%
All Other Victims

Premise: Forms given to data enable authors to convey a message to a reader.

How does the reader feel when going through a visualization?

Where is efficiency helpful but where does it conflict with the message of the piece?

How might we defy reader expectations or have them confront prior held beliefs?

guns.perisopic.com

SEX

RACE

AGE GROUP

REGION

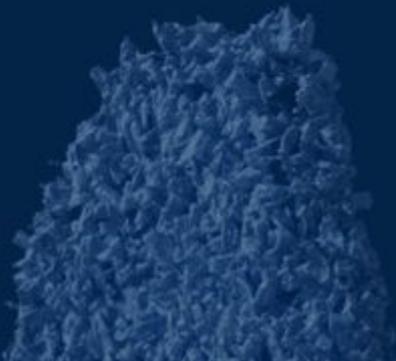
GUN TYPE

VICTIM C

A Treaty To End Plastic Pollution. Forever.

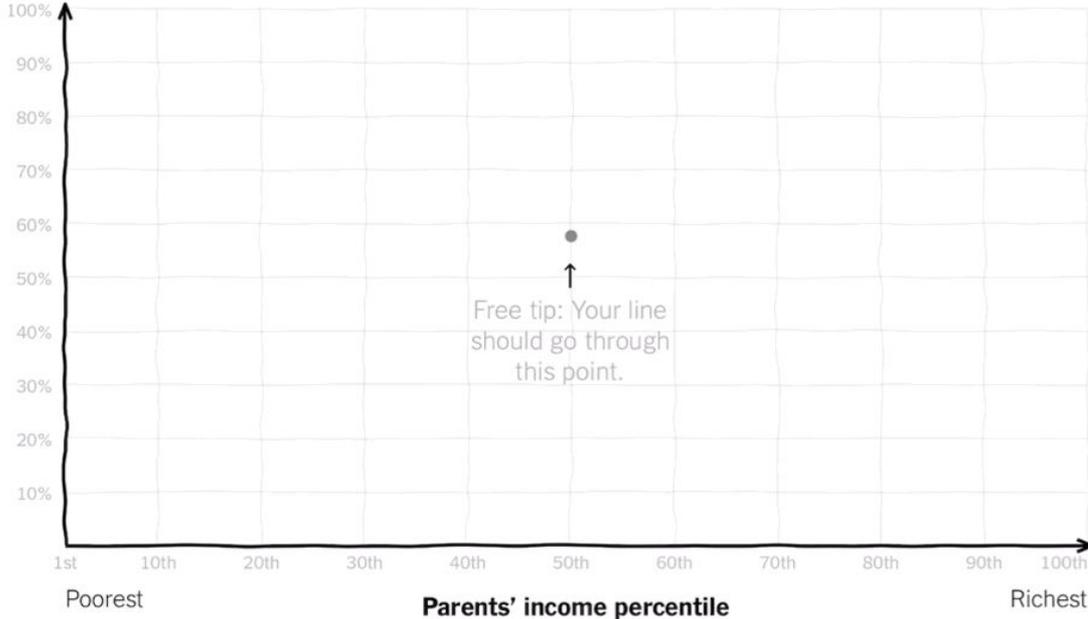
World leaders must take steps to drastically limit the
impact of plastics on the environment and human
health

CHOOSE OUR FUTURE



Draw your line on the chart below

Percent of children who attended college



I'm done

Start over

Offers: A way to convey messages with logos and pathos.

How to invoke emotional response.

How to challenge reader assumptions.

How to understand the process by which messages and meaning are interpreted.



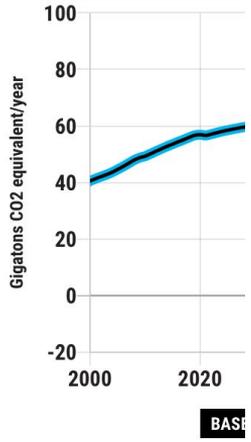
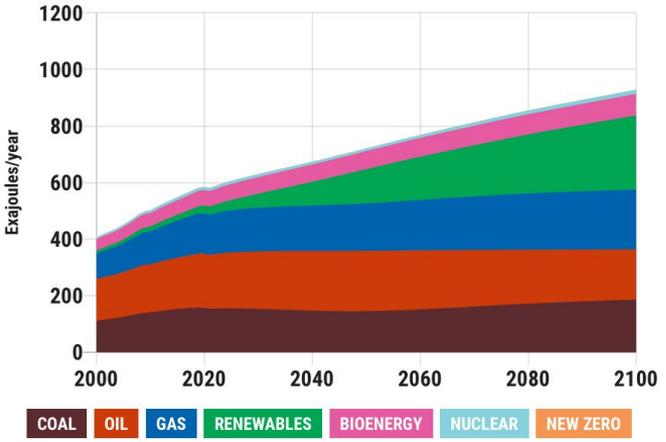
Adapt based on your audience

- Focus on your user's goal
- Use appropriate language and terminology
- Assess engagement based on medium and level of interaction expected

How can data help us think?

Global Sources of Primary Energy

Greenhouse Gas Ne



4 Perspectives

As representation

As task

As message

| As dialogue

Why and how different groups do data visualization. How you can think about it in your work.

Simulation interface showing various sliders for Energy Supply, Transport, Buildings and Industry, and Growth. Each slider has a 'status quo' marker and a control knob.

Data <- Tool -> Collaborator

Premise: Data as humane dynamic media.

The designer creates media for thought, elevating the reader to an author of tools and co-creator of meaning.



```
function drawScene (canvas) {
  ctx = canvas.getContext("2d");
  extendCanvasContext(ctx);

  canvasWidth = parseInt(canvas.getAttribute("width"));
  canvasHeight = parseInt(canvas.getAttribute("height"));

  drawSky();
  drawMountains();
  drawTree();
}

//-----
//
// sky
//

function drawSky () {
  ctx.save();

  var gradient = ctx.createLinearGradient(0,0,0,canvasHeight);
  gradient.addColorStop(0, "#b4c0fe");
  gradient.addColorStop(1, "#d3f8ff");

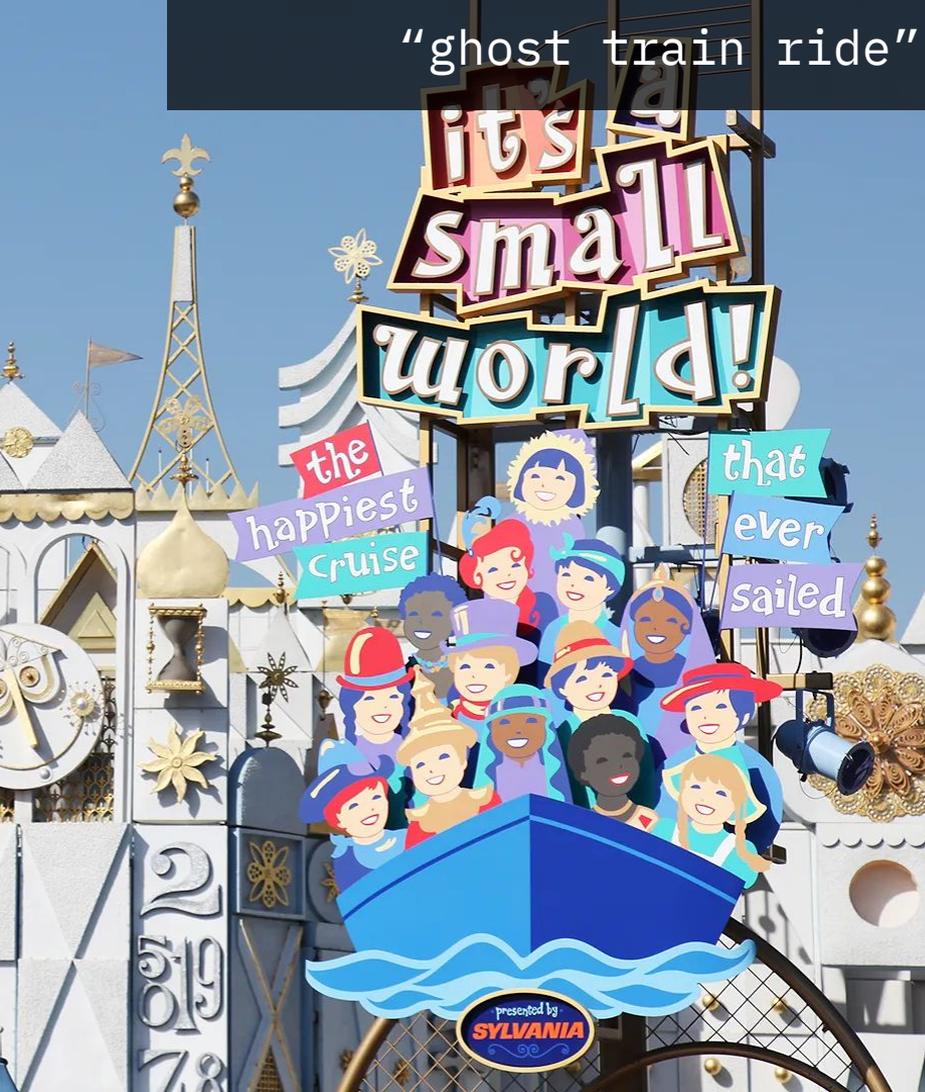
  ctx.fillStyle = gradient;
  ctx.fillRect(0,0,canvasWidth,canvasHeight);

  ctx.restore();

  ctx.fillStyle = "#ecf8e9";
  ctx.fillCircle(300, 99, 67);
}

//-----
//
```

"ghost train ride" vs "open world"



Mismanaged Waste ⓘ

71.7

Million Metric Tons



Incinerated Waste ⓘ

129.3

Million Metric Tons



Landfill Waste ⓘ

118.4

Million Metric Tons



Gross GHG ⓘ

2755.7

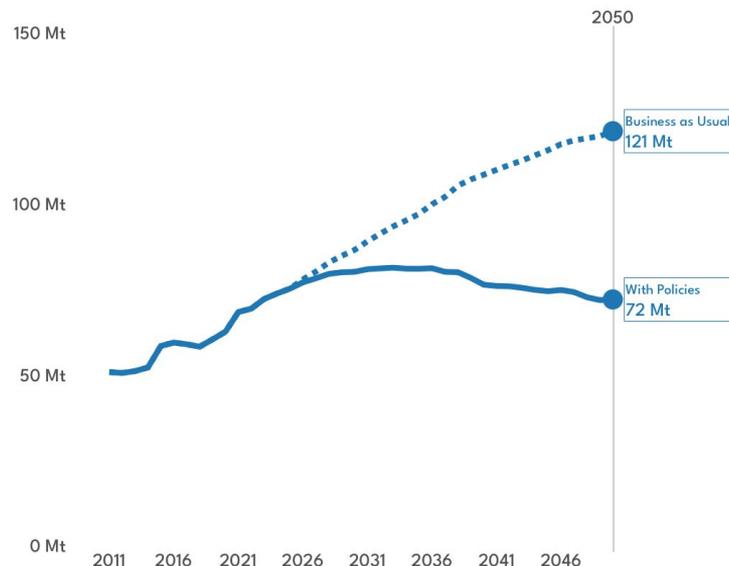
Million Metric Tons



Policies

 High > Reduction in Single Use Packaging ⓘ 90 > % Reduced Additives ⓘ Ban Polystyrene Packaging ⓘ Ban Waste Trade ⓘ Cap to 2020 Virgin Production ⓘ 40 > % Min Recycle Collection Rate ⓘ 80 > % Packaging Reuse / Life Extension ⓘ 40 > % Min Recycled Content ⓘ High > Packaging Consumption Tax ⓘ 100 > Billion USD for Plastic Recycling ⓘ 50 > Billion USD for Waste Infrastructure ⓘ Custom ⓘ

Global Annual Rate of Mismanaged Waste as Million Metric Tons ☰

[With Policies](#)[Business as Usual](#)

Example:
Finding a solution to the plastics crisis.

A layered experience in which the user can simulate different policies.

An invitation to build outside the original designer's intention.

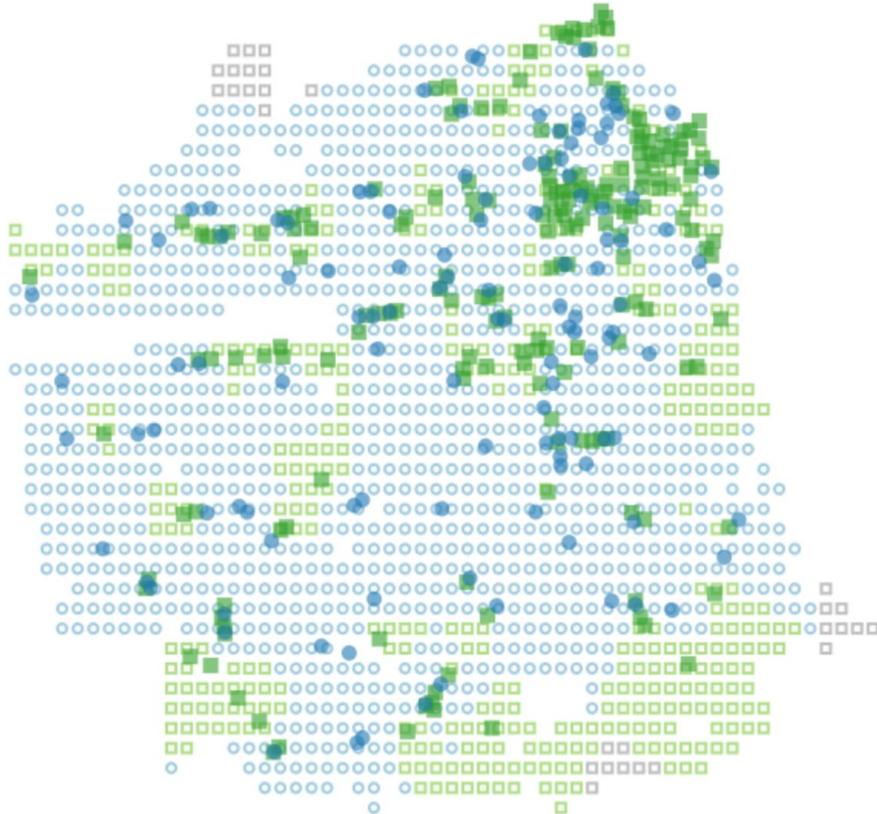


[https://
global-plastics-tool
.org](https://global-plastics-tool.org)



Progress:

Keep going! You have spent 0% of your budget (0% on rezoning and construction subsidy, 0% on transit improvement and subsidy). Goal: 80% choose supermarket. You can also [reset your design and try again](#).



Summ

74% c

24% c

2% m

0%

Buildi

Left cl

Su

Fa

Re

Re

Trans

Invest

travel

Offers: Co-creation and user agency.

Often leaning on game design concepts.

How to teach with/without tutorializing.

How to create spaces to interrogate assumptions.

How to build media to be repurposed.

How to design experiences where the user is co-author.

foodsimsf.com

Keep it going: Check-in before we go to future.



What's something you
learned today?

Gulf of Alaska Common names No temperatures

Aleutian Islands Common names No temperatures

Scatter 1 Scatter 2

Pacific cod Pacific cod

2013 None

Scatter 1 Scatter 2

Pacific cod Pacific cod

2000 None

Loading...

Loading...

kg / hectare

kg / hectare

19.77 kg/hectare overall CPUE

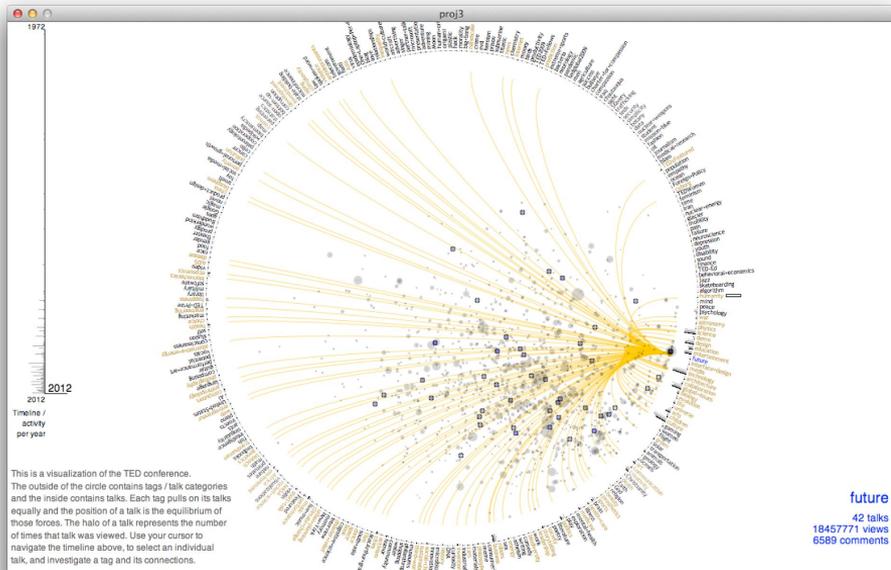
22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



<Break>



Today

Why care about visualization

Human visual system allows for visual reasoning and more efficient interpretation of data.

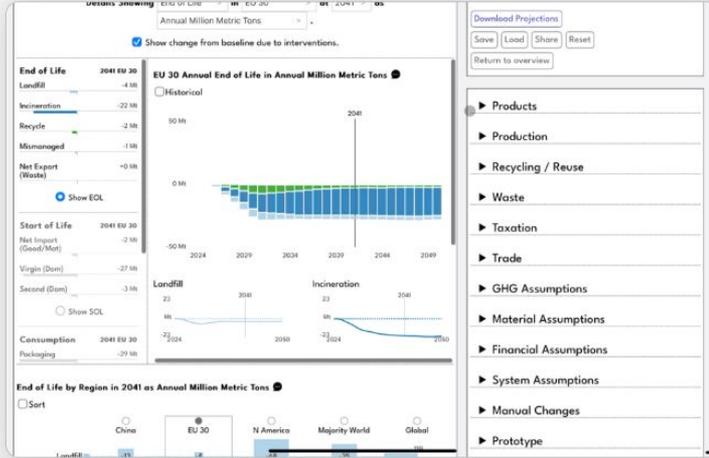
How to design data visualizations

Encoding devices, careful use of color, patterns for higher density graphics.

How to think about data visualization

Visualization as representation, task, message, and dialogue.

> How to continue your journey



Interactive Data Science

👋 Hello! I'm [Sam](#). This website houses my courses, workshops, and lectures on interactive data, participatory science, democratized AI, and user-centered data visualization.

🚀 Get learning! Try [my open source online course](#) (free and self-paced) or, if you are in Berkeley, [participate in-person](#).

[Course](#) / [Why](#) / [Upcoming](#) / [Materials](#) / [Sign Up](#) / [About](#)

Keep going:
Resources online.

[https://
interactive
data
science
.courses](https://interactive-datascience.courses)

Tools to visualize

Many visualization practitioners draw “by hand” but there is a spectrum of tools depending on your need. Start with message / experience.

more speed

RAWGraphs

Datawrapper



Power BI



Separate [tools-focused talk](#) we gave with more details



p5.js



Sketchingpy

more control

Tools to visualize

Many visualization practitioners draw “by hand” but there is a spectrum of tools depending on your need. Start with message / experience.

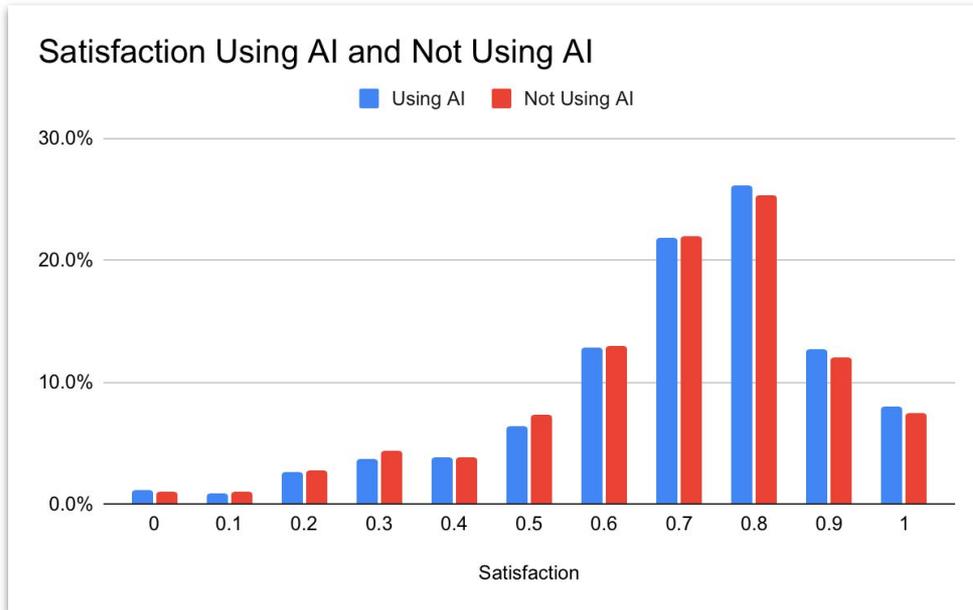


What tools do you use to make visualizations?
Share with a partner and then share with the
group!

Tools to visualize

Many visualization practitioners draw “by hand” but there is a spectrum of tools depending on your need. Start with message / experience.

more speed



more control

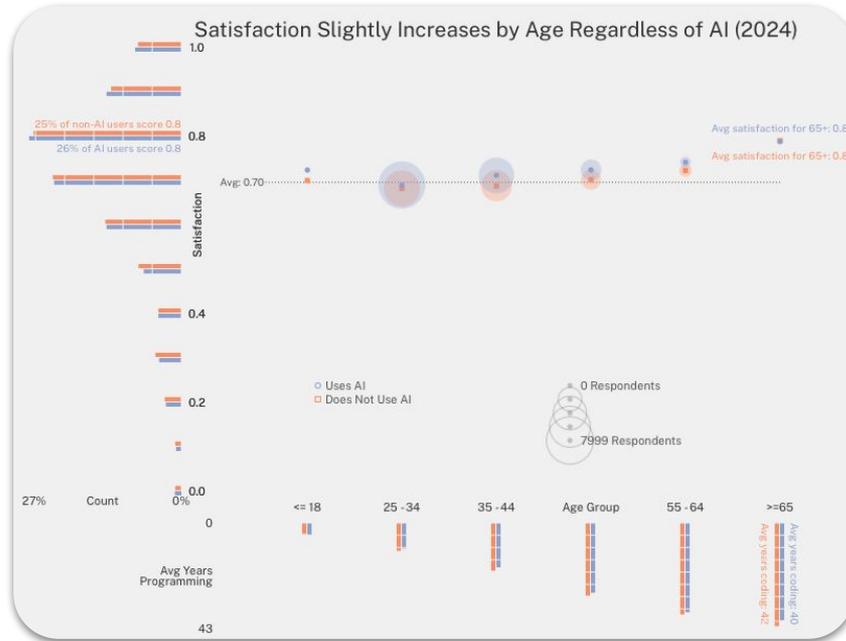


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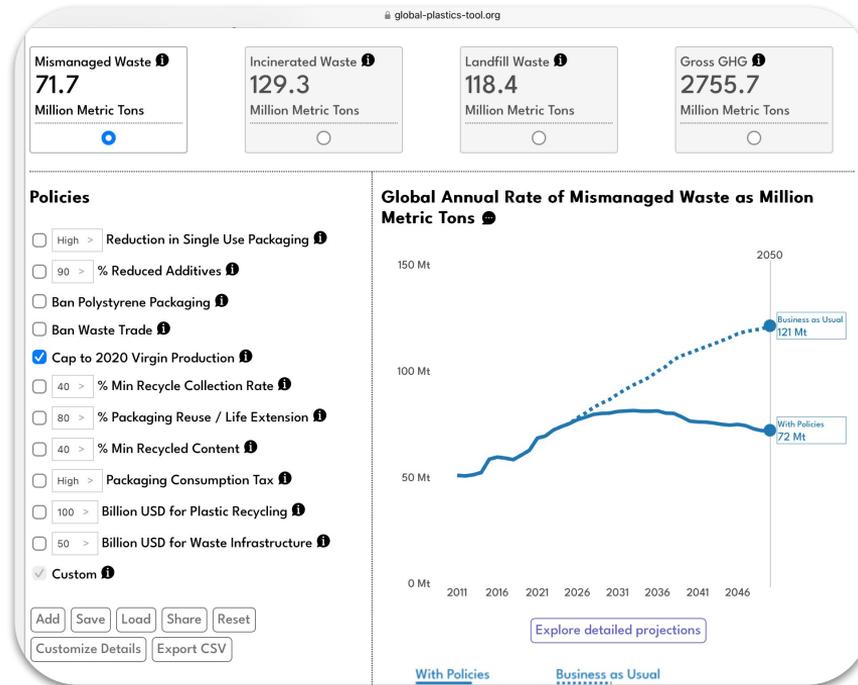
Separate [tools-focused talk](#) we gave with more details

more control

Tools to visualize

Many visualization practitioners draw “by hand” but there is a spectrum of tools depending on your need. Start with message / experience.

more speed



Separate [tools-focused talk](#) we gave with more details

more control



AI assistants like Claude tend to perform well in producing simple graphics like a bar plot in matplotlib (prebuilt-graphics in Python). In general, more advanced graphics require hands-on experience. Try it out with the source data we started with! [Here is a tutorial.](#)



Gulf of Alaska Common names No temperatures

Aleutian Islands Common names No temperatures

Scatter 1 Scatter 2

Pacific cod None

2013

Scatter 1 Scatter 2

Pacific cod None

2000

Loading...

Loading...

kg / hectare 5 10 15

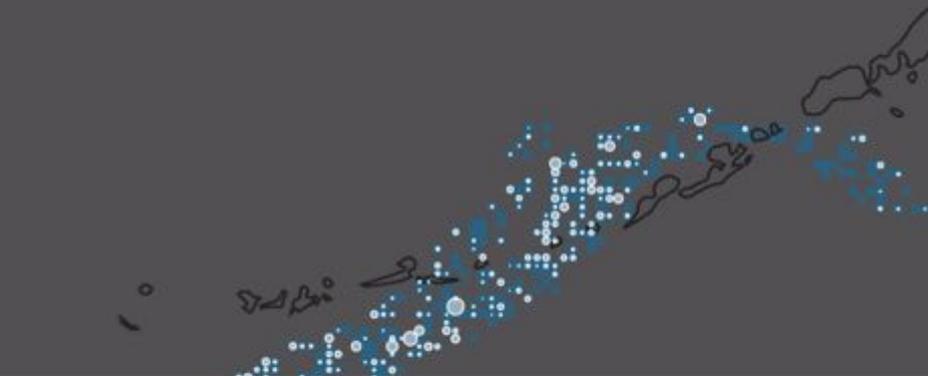
kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



Works Cited / Further Reading

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