

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

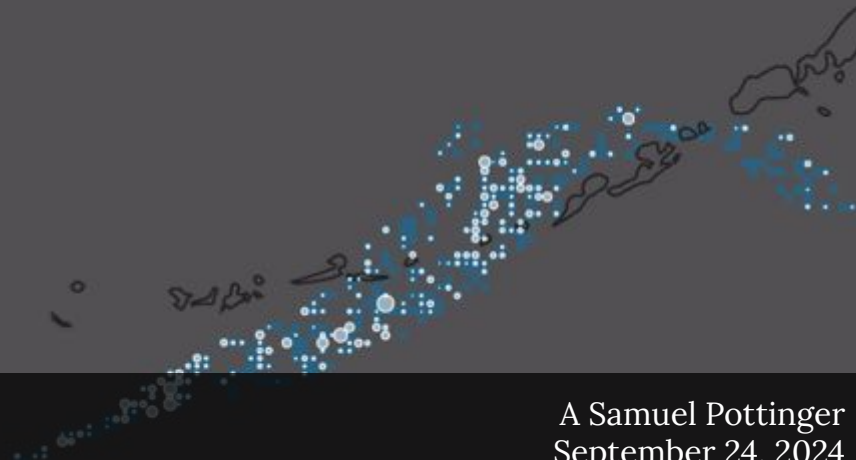
kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



Data Visualization and Interactive Science

A Samuel Pottinger  
September 24, 2024  
Schmidt Center for Data Sci and Env  
EcoTech UC Berkeley Workshop Series



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  
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

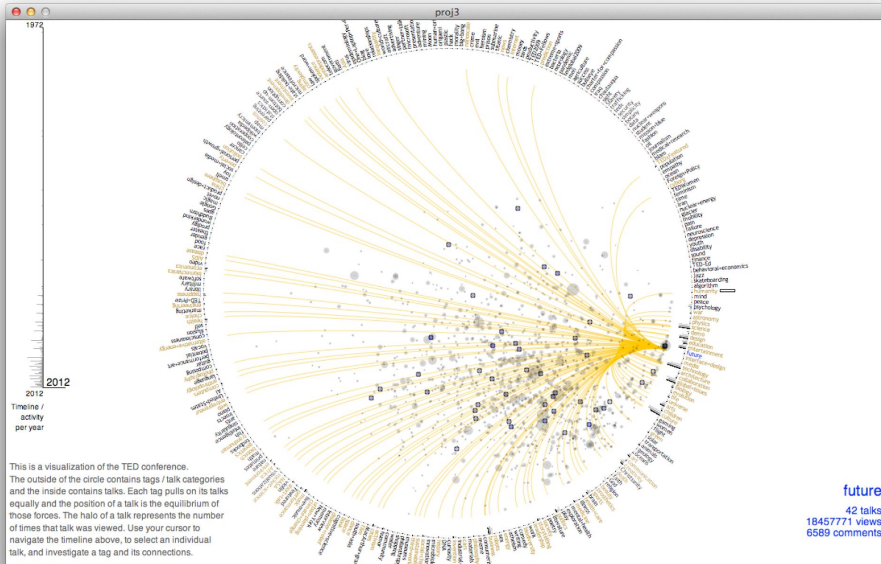
# Today

---

4 different viewpoints on what data visualization is and how to do it well.

Ideas for how to explore data visualization (and interactive science) at a deeper level within your work.

Resources to continue your data viz journey.



Gulf of Alaska Common names No temperatures

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Scatter 1 Scatter 2

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2013

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Loading...

Loading...

kg / hectare 5 10 15

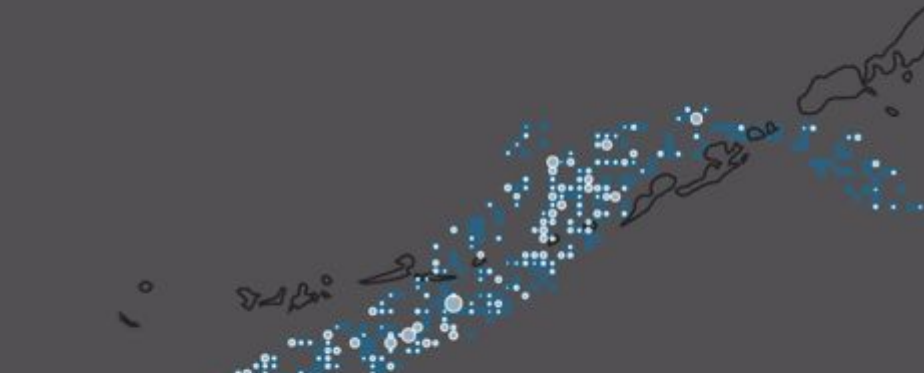
kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

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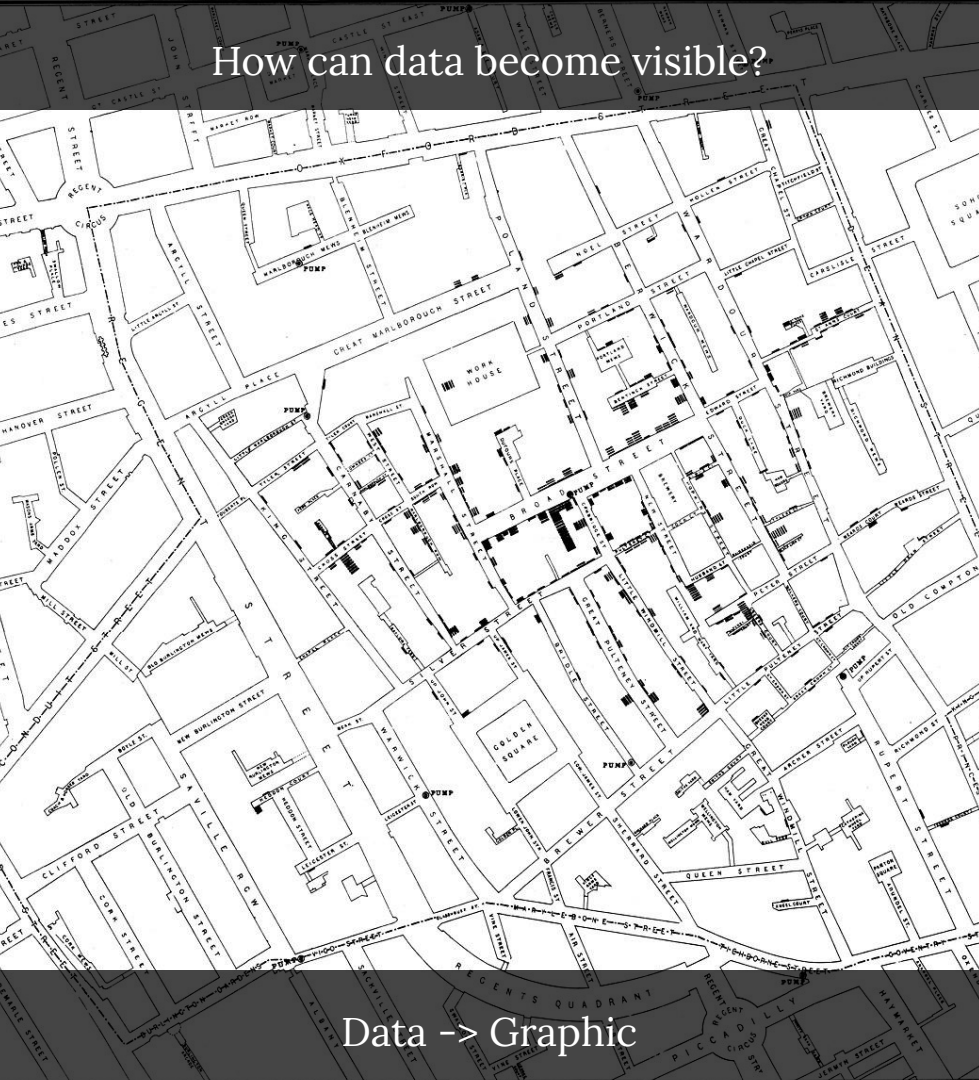
Dynamic scaling enabled

Dynamic scaling enabled



Discussion Portion

How can data become visible?



Data -> Graphic

## Data Visualization in 4 Acts

---

| 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.

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 is the relationship between wolves and moose in Isle Royale?

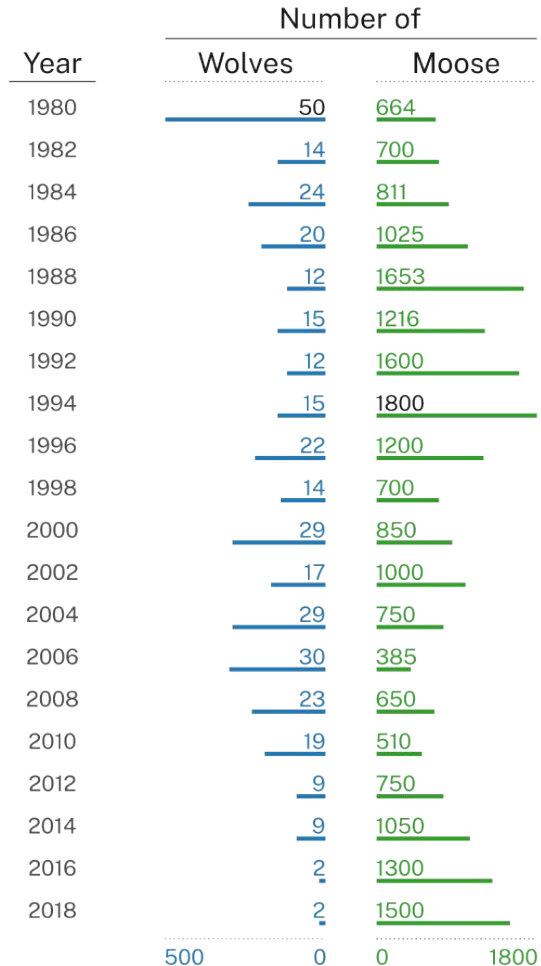
What year saw the most moose?

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

What year saw the most moose?



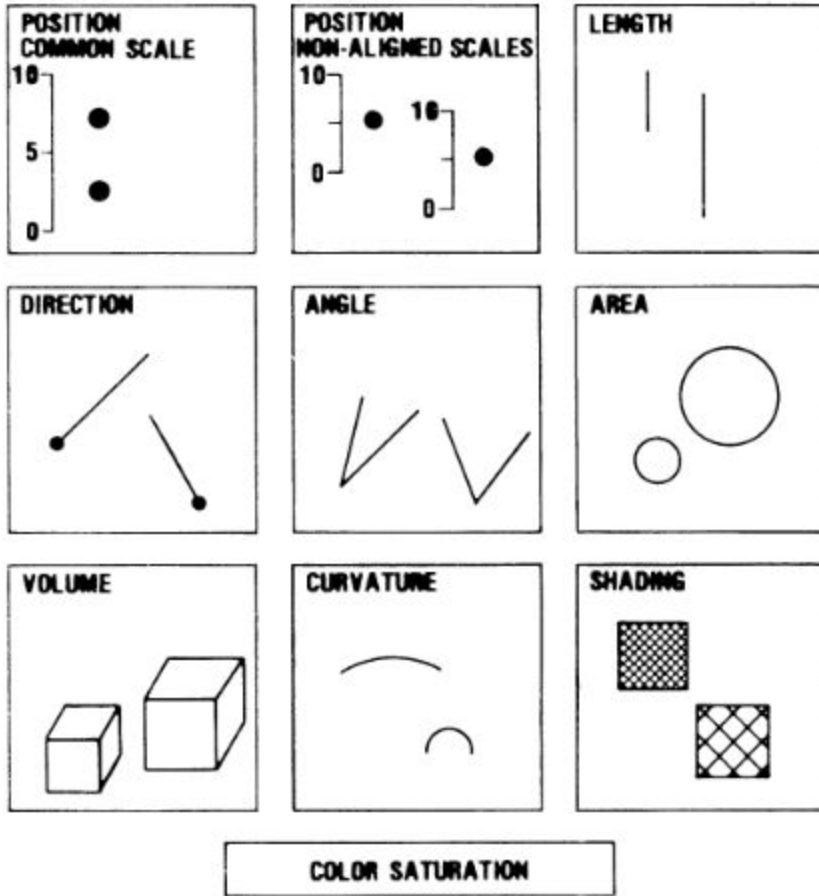


Figure 1. Elementary perceptual tasks.

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

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

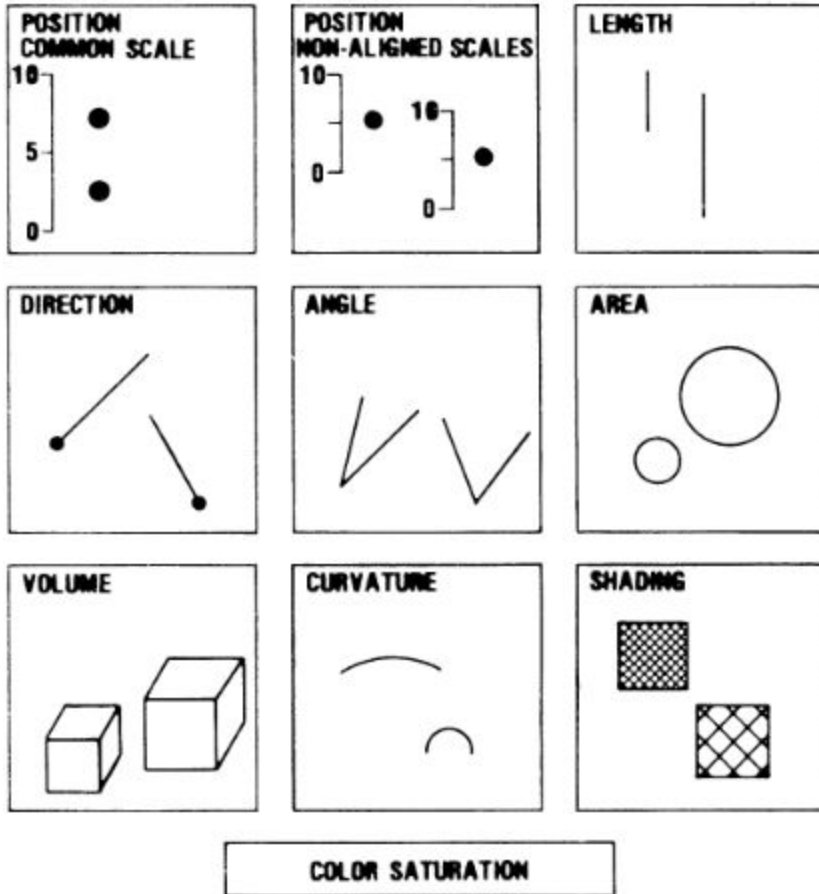
What visual encodings are better than others?

How do we make visualizations accessible?

# Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods

WILLIAM S. CLEVELAND and ROBERT MCGILL\*

---



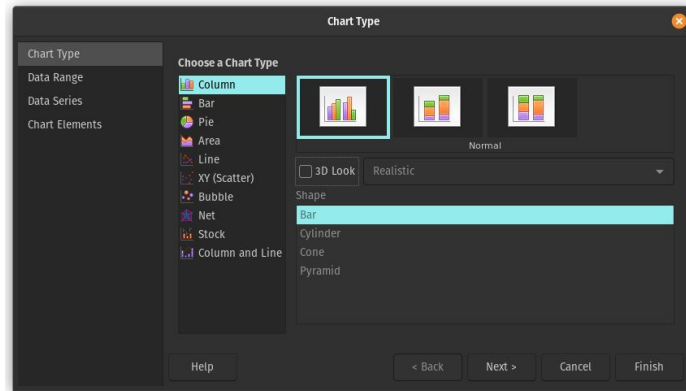
The following are the 10 elementary tasks in Figure 1,  
ordered from most to least accurate:

1. Position along a common scale
2. Positions along nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation

Figure 1. Elementary perceptual tasks.

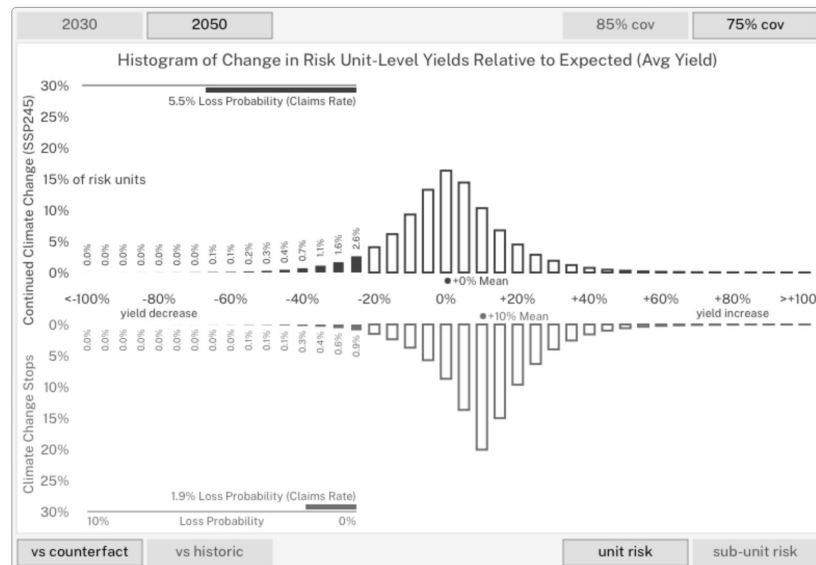
**Offers:** Flexibility beyond the chart wizard but principles to guide us.

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



The following are the 10 elementary tasks in Figure 1, ordered from most to least accurate:

1. Position along a common scale
2. Positions along nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation



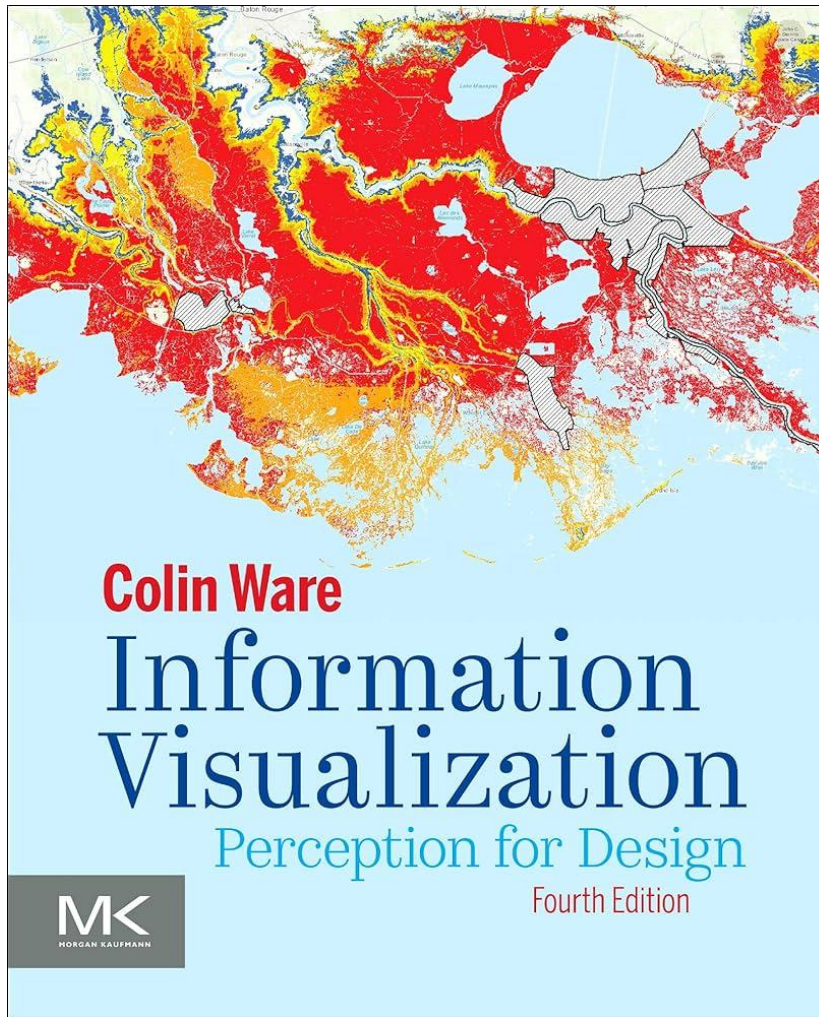
**How to use it:** Learn more about human visual system to understand when to use different chart types or encoding devices.

The following are the 10 elementary tasks in Figure 1, ordered from most to least accurate:

1. Position along a common scale
2. Positions along nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation



Colin  
Ware



**Summary:** We use graphics representation of data.

Visual processing

Encoding

Data ink

Accuracy

# How can users ask questions of data?

## Data Visualization in 4 Acts

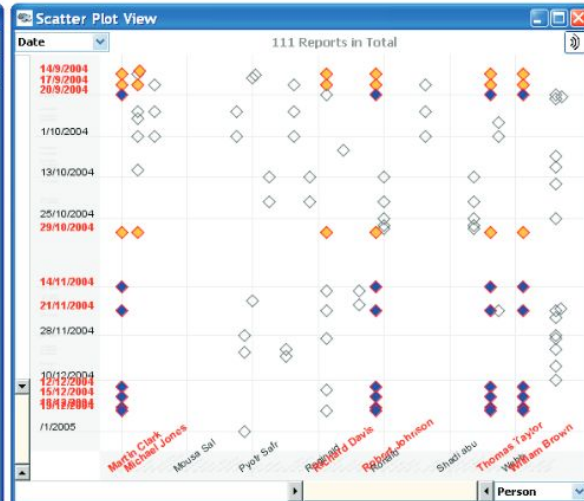
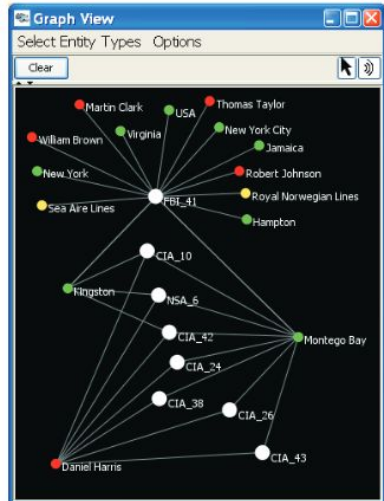
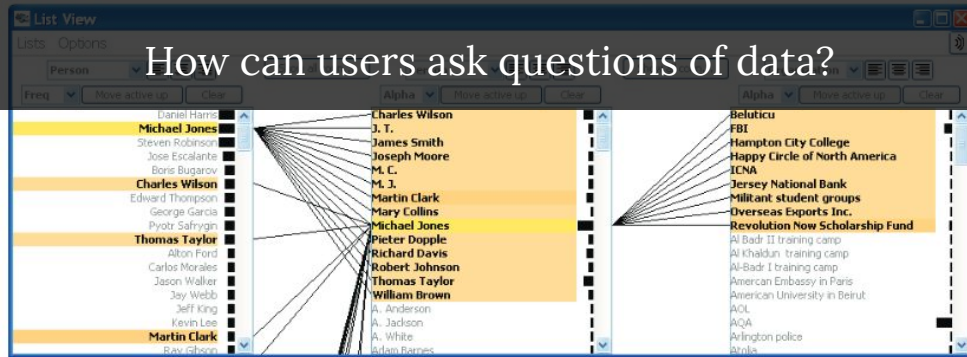
As representation

| As task

As message

As dialogue

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



**Text View**

FBI\_11 FBI\_35 FBI\_41

Source: Miami field office  
Date: 15/12/2004

In light of the information in FBI report for 14 November, 2004, a search was made of our computer files to see if there were other occurrences of such double bookings. PI work data was reviewed for the period 14 November, 2004 to 21 November, 2004. New York City and the Sea Air Lines in Hampton, VA, Royal Norwegian Lines reported that two men named Thomas Taylor and Robert Johnson had, on 20 September, 2004, booked first-class accommodations on the "Viking Holiday" that left NYC on 14 November, 2004 and returned to NYC from Montego Bay on 21 November,

Data > Graphic > User

**Premise:** Visualizations are part of a broader user journey.

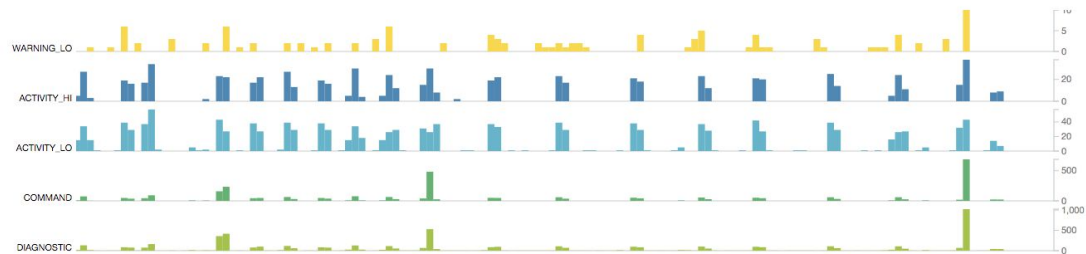
A structured way to think about the user in the context of data visualization.

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	2016-013T19:57:15.033
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	2016-013T19:56:55.956
DIAGNOSTIC	DWN_EVR_TC_TIME_ARRIVED	dwn	The time correlation (TC) time arrived: expected=TRUE, time=1e28c022:f1f2c000.	2016-013T19:56:53.993
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	2016-013T19:56:51.033
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	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).

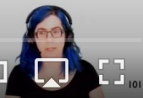
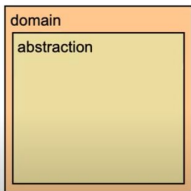
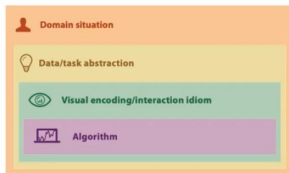
Binx talks about how people had never seen their data before visually and the periodicity of events was revelatory for example.

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

119



Share



14K views 2 years ago

Task Abstraction Lecture, 2021.

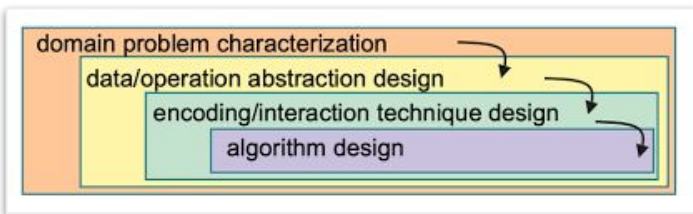
Task Abstraction (Ch 3), Visualization Analysis & Design by Tamara Munzner, CRC/Routledge 2014.

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.

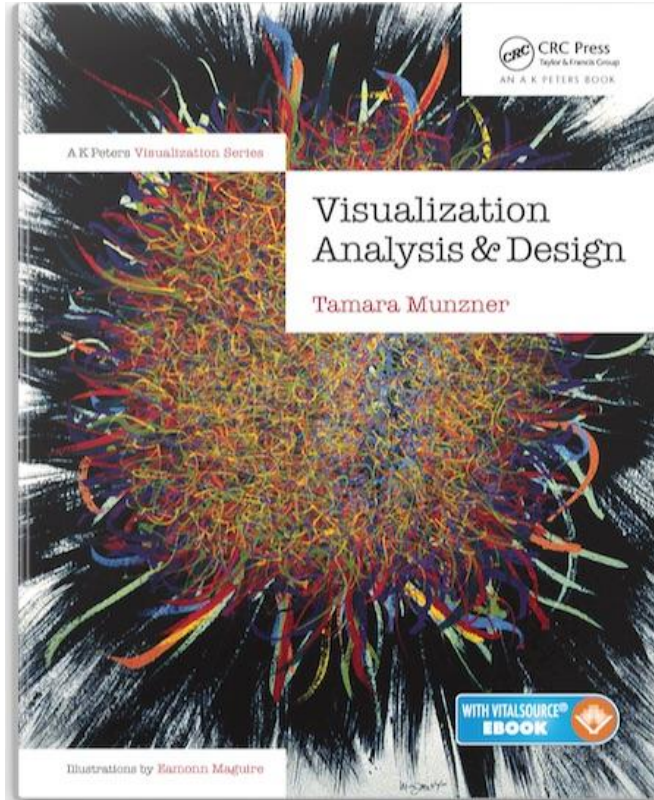
Fits within a broader modern user experience design dialogue.



**How to use it:** Chart out the tasks that you imagine your audience taking and what questions they are asking. The simplest form is chat with some users before building your graphics and later walk through the journey of how those would be answered.



Tamara  
Munzner



**Summary:** We use visualizations in tasks.

Domains, questions, data, techniques

User-Centered Design

User journeys

Situated use and diary study

How can data tell stories?



## Data Visualization in 4 Acts

---

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.

# 11,356

PEOPLE KILLED

724 | 6%  
Children under 18

AGE 0

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](https://guns.perisopic.com)

SEX

RACE

AGE GROUP

REGION

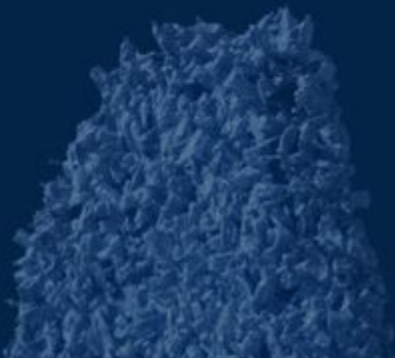
GUN TYPE

VICTIM C

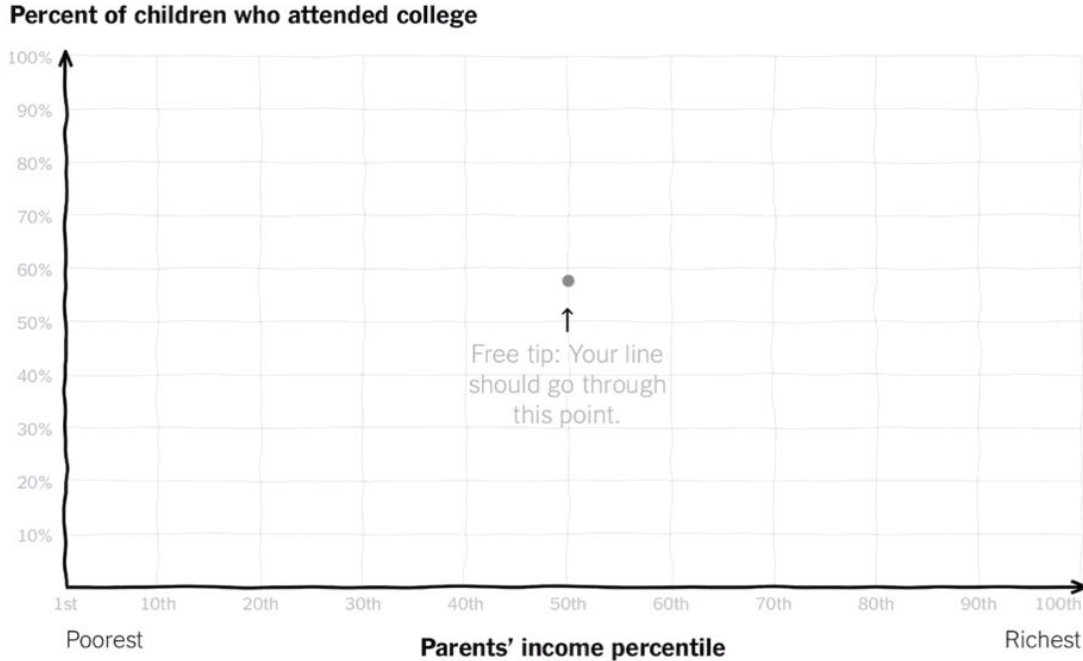
# A Treaty To End Plastic Pollution. Forever.

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



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.

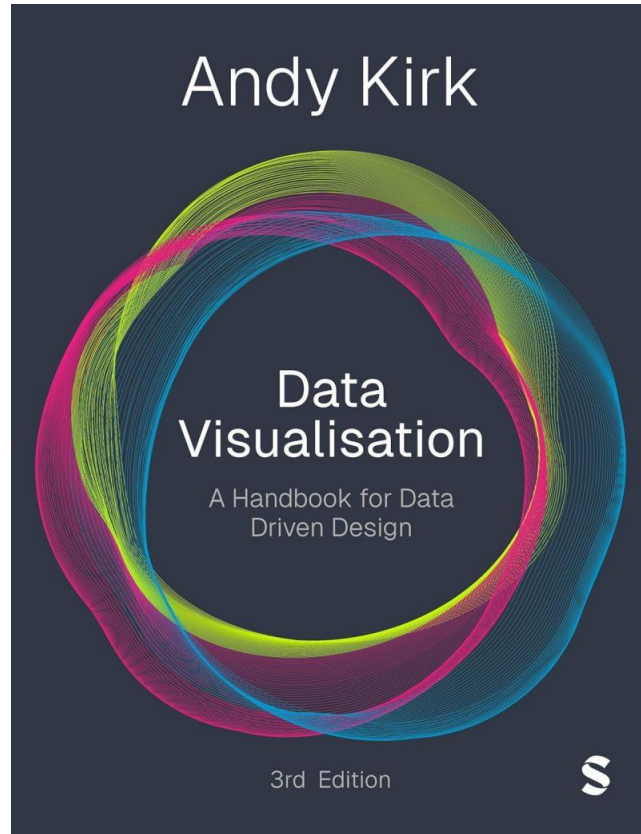
How to understand the process by which messages and meaning are interpreted.

**How to use it:** Chart out the emotional journey you imagine your readers taking. Ask how the graphical decisions help deliver that emotional experience or detract from it. Make choices which trade off the emotional experience with the most direct representation of the data.





Andy  
Kirk



**Summary:** Visualizations are data experienced.

Movements

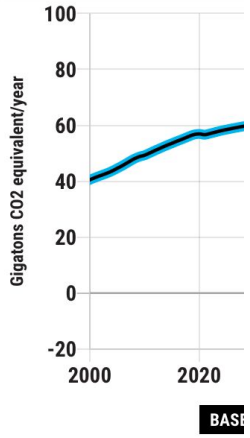
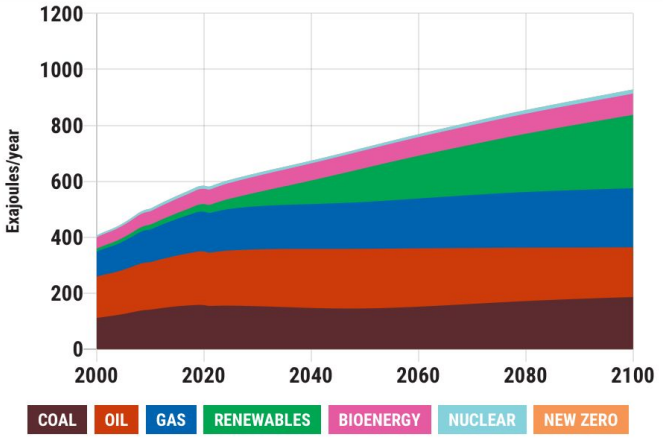
Diagrammatic reading

Sketch-based development

Social mediation

# How can data help us think?

Global Sources of Primary Energy Greenhouse Gas Ne



## Data Visualization in 4 Acts

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.

Energy Supply

Coal  Renewables

Oil  Nuclear

Natural Gas  New Zero-Carbon

Bioenergy  Carbon Price

Transport

Energy Efficiency  Electrification

Buildings and Industry

Energy Efficiency  Electrification

Growth

Population  Economic

Data <- Tool -> Collaborator

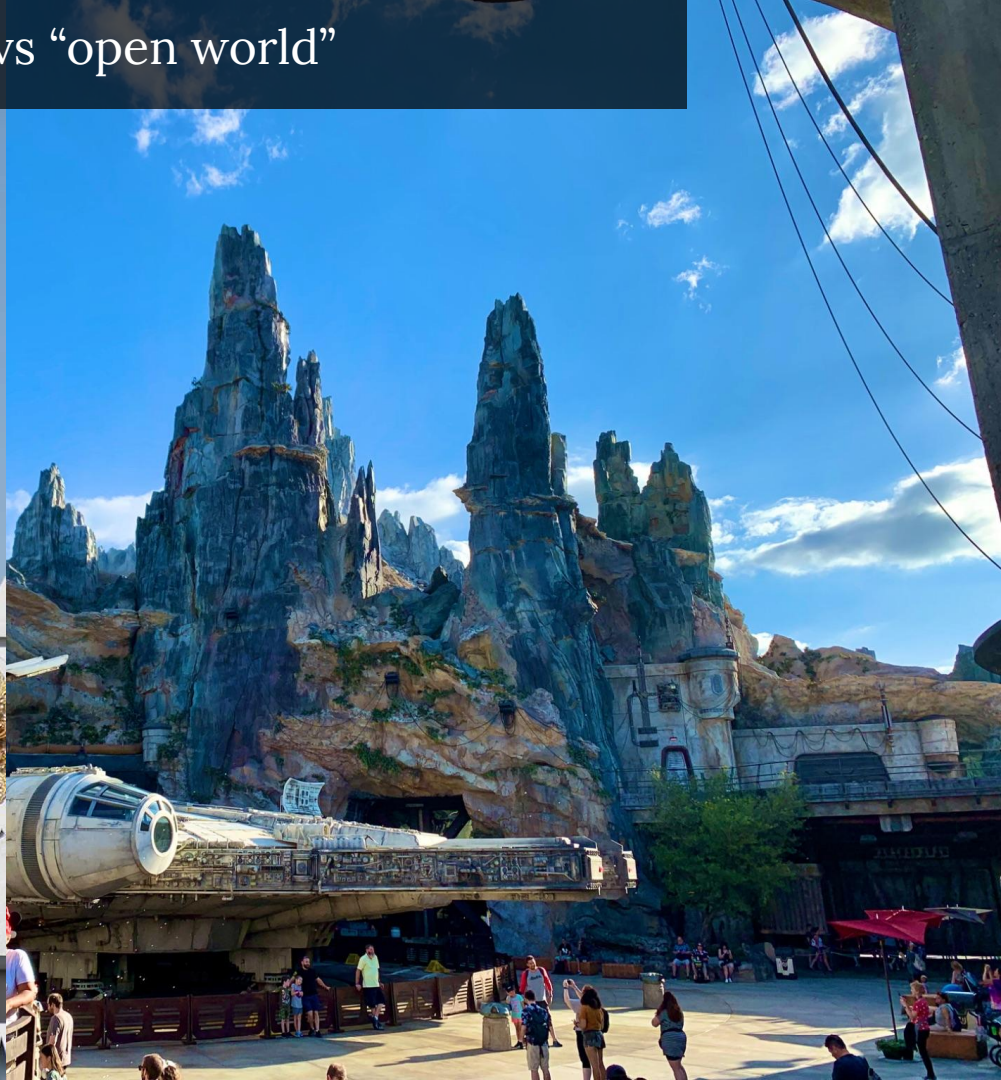
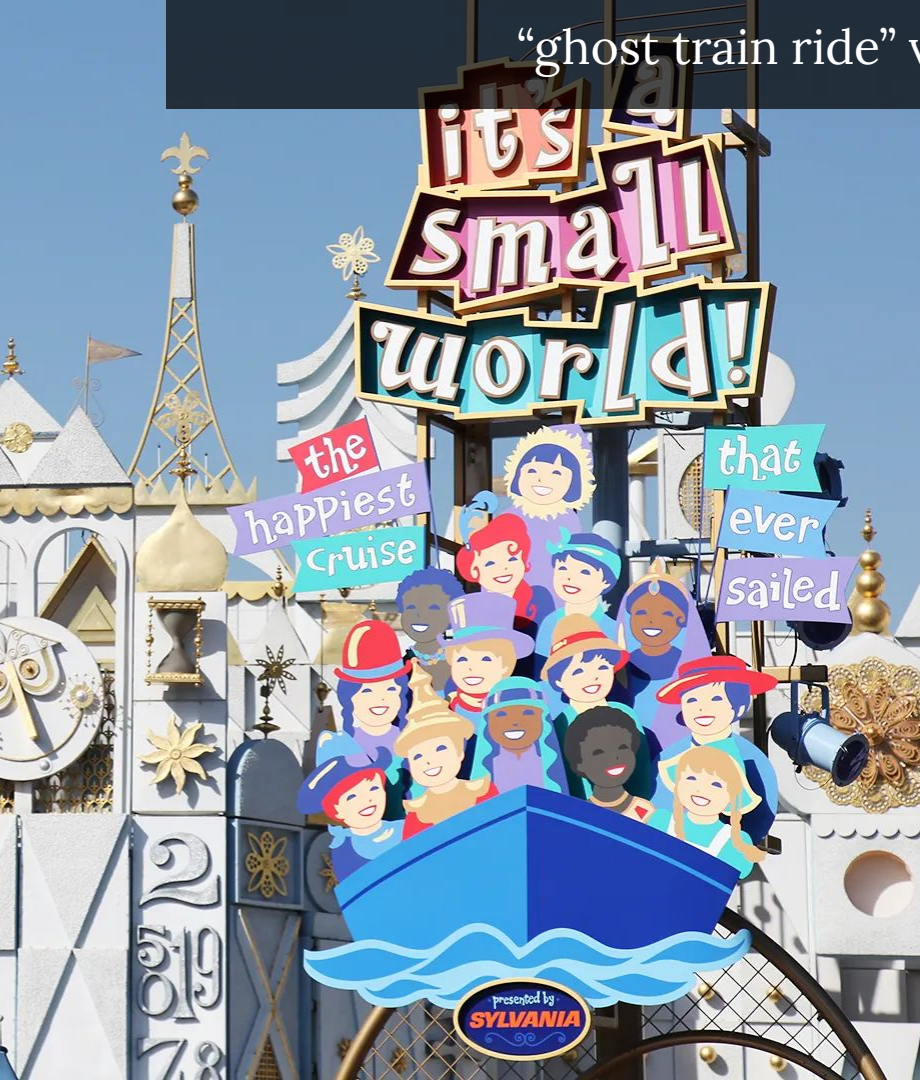
## Premise: Data as humane dynamic media.

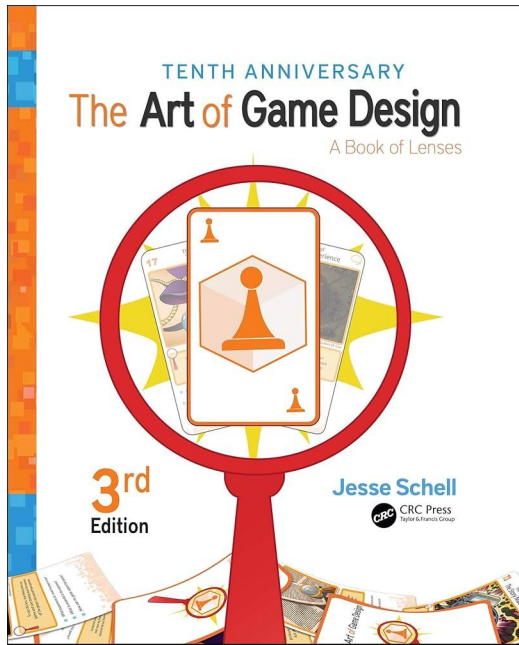
The designer creates media for thought, elevating the reader to an author of tools and co-creator of meaning.



```
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 = "#ecf88a";  
  ctx.fillCircle(300, 99, 67);  
}  
  
//-----  
//
```

“ghost train ride” vs “open world”





## Motivations for Play in Online Games

Author: Nick Yee | [AUTHORS INFO & AFFILIATIONS](#)

Publication: CyberPsychology & Behavior • <https://doi.org/10.1089/cpb.2006.9.772>

41,820 / 1,242

[Permissions & Citations](#)



[GET ACCESS](#)

### Abstract

An empirical model of player motivations in online games provides the foundation to understand and assess how players differ from one another and how motivations of play relate to age, gender, usage patterns, and in-game behaviors. In the current study, a factor analytic approach was used to create an empirical model of player motivations. The analysis revealed 10 motivation subcomponents that grouped into three overarching components (achievement, social, and immersion). Relationships between motivations and demographic variables (age, gender, and usage patterns) are also presented.

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

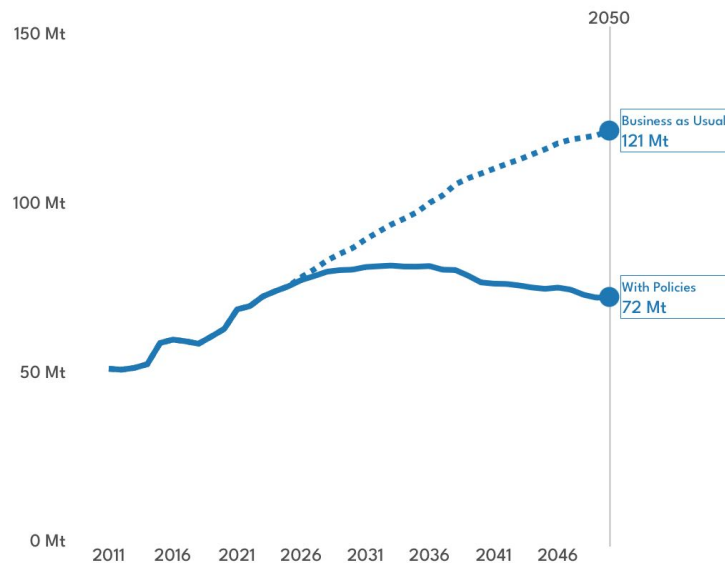
Million Metric Tons



## 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 PoliciesBusiness as Usual

**Example:** Finding a solution to the plastics crisis.

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

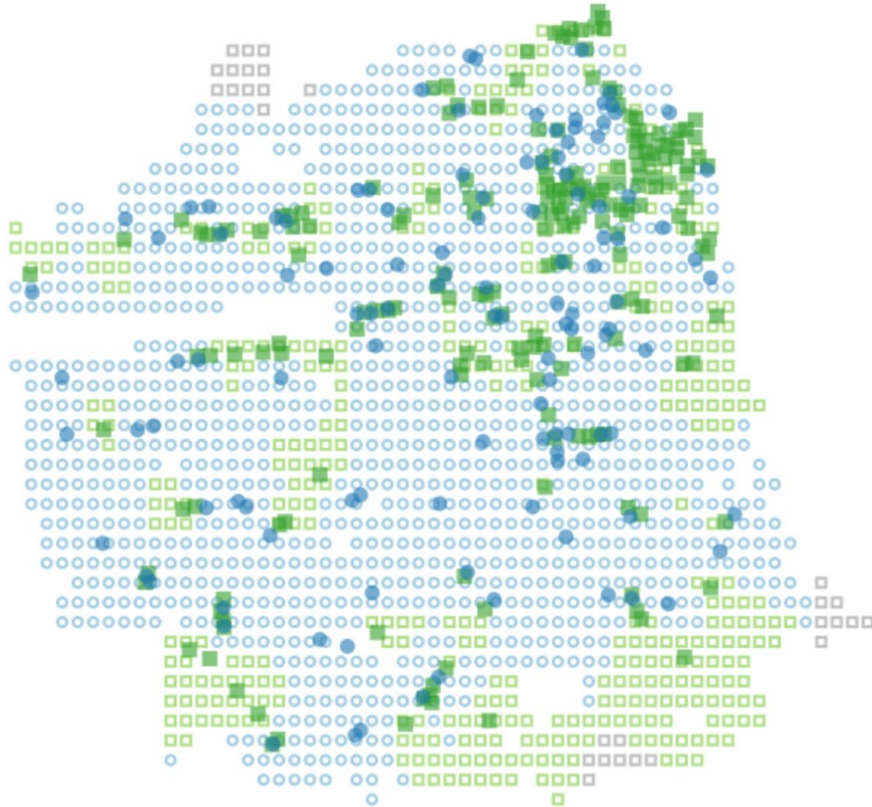
An invitation to build outside the original designer's intention.

<https://global-plastics-tool.org>



### 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.

**How to use it:** Think about how your audience could be co-creators with you. What kinds of graphics or experiences allow them to ask questions beyond what you presented. How could your work empower them to take your results and bring them into their own work?





Bret  
Victor

# Media for Thinking the Unthinkable

Bret Victor

April 4, 2013  
MIT Media Lab

**Summary:** Create spaces  
for the user to converse  
with data.

Kinesthetic projection

Ludonarrative

Player agency

Loop-based design

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 5 10 15

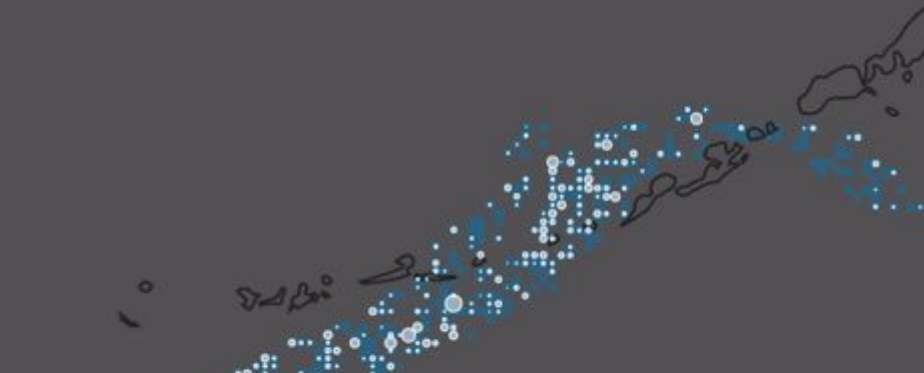
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19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



# Summary

**How to use it:** Learn more about human visual system to understand when to use different chart types or encoding devices.

**How to use it:** Chart out the tasks that you imagine your audience taking and what questions they are asking. The simplest form is chat with some users before building your graphics and later walk through the journey of how those would be answered.

**How to use it:** Chart out the emotional journey you imagine your readers taking. Ask how the graphical decisions help deliver that emotional experience or detract from it. Make choices which trade off the emotional experience with the most direct representation of the data.

**How to use it:** Think about how your audience could be co-creators with you. What kinds of graphics or experiences allow them to ask questions beyond what you presented. How could your work empower them to take your results and bring them into their own work?

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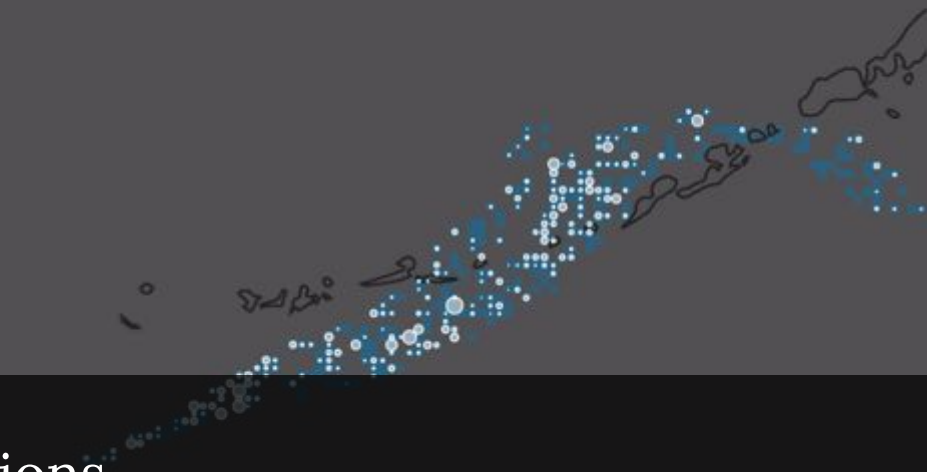
kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



Questions

# If you want to learn more...

---

## Interactive Data Science

👋 Hello! I'm Sam. I work at the Schmidt Center for Data Science and Environment at UC Berkeley. This website discusses my course, workshops, and lectures on interactive data, interactive science, and data visualization. Get notified about upcoming courses and workshops!

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

**Students:** I have upcoming lectures, workshops, and a **Spring 2025 course**. There's more details and a form at:

<https://interactivedatascience.courses>

**If you want to learn more...**

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Faculty and staff: we have a Slack!

<https://dse.berkeley.edu/about/community>

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



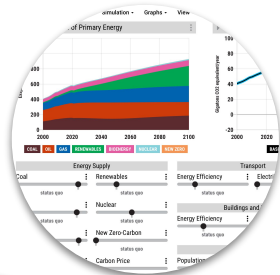
Hands-On Portion

# Three examples to consider

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Break into three groups: try out a visualization and report back.

[en-roads.climateinteractive.org](http://en-roads.climateinteractive.org)



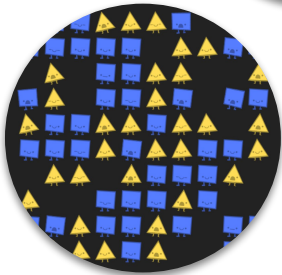
What emphasizes efficiency?

What are the tasks imagined by the designers?

What is the emotional journey of using the visualization?

How is the user a co-author in the experience?

Bonus pending time: [foodsimsf.com](http://foodsimsf.com)



[ncase.me/polygons](http://ncase.me/polygons)



[incomegaps.com](http://incomegaps.com)



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Scatter 1 Scatter 2

Pacific cod Pacific cod

2013 None

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2000 None

Loading...

Loading...

kg / hectare 5 10 15

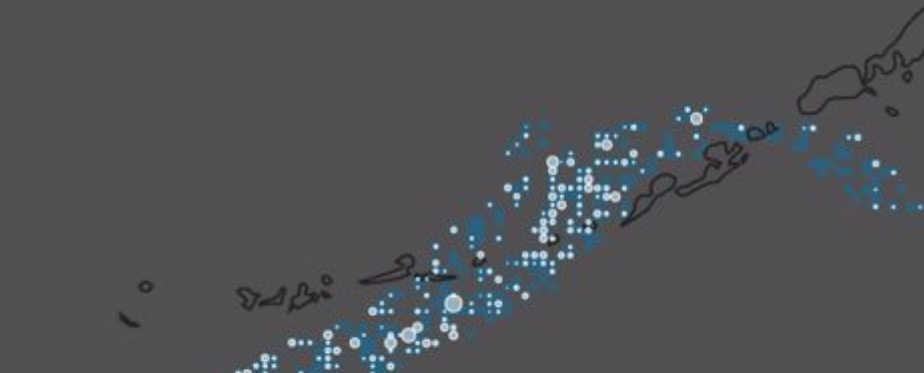
kg / hectare 5 10 15

19.77 kg/hectare overall CPUE

22.18 kg/hectare overall CPUE

Dynamic scaling enabled

Dynamic scaling enabled



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