

Mind the Gap: An incomplete picture of statistics, statisticians, & statistics education

Matthew Beckman
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June 25, 2023
Maleny, Australia

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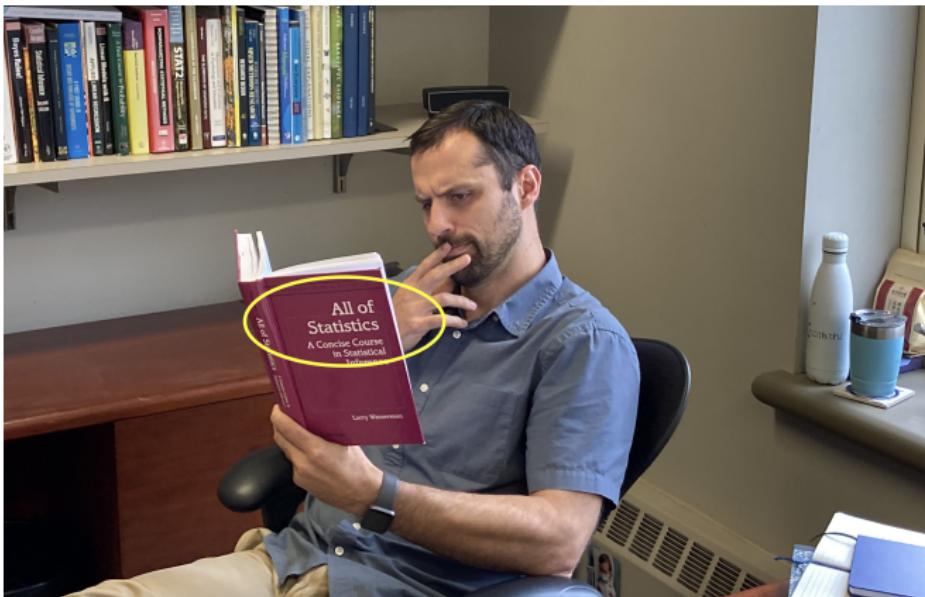


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- ... on “reconceptualising data and data-ing”

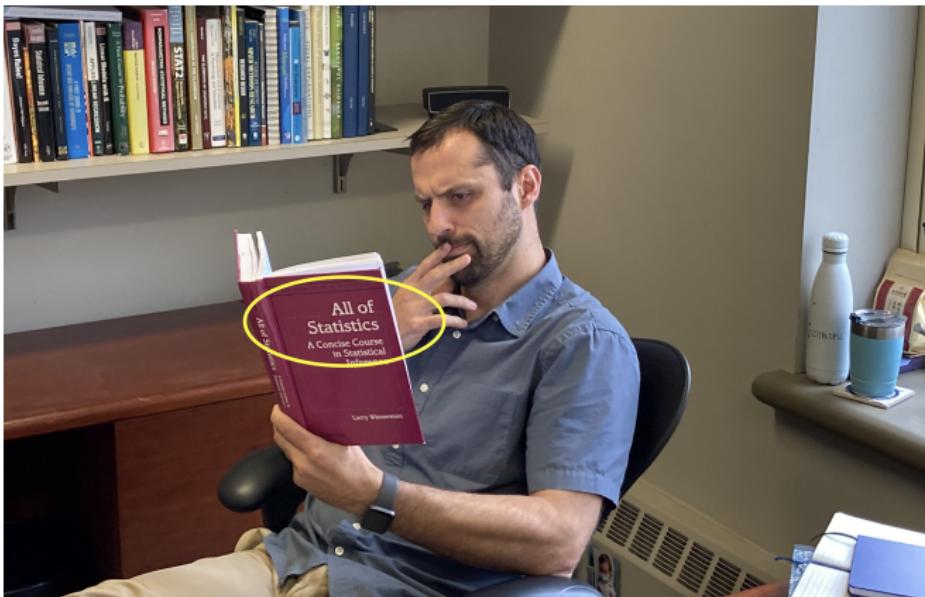


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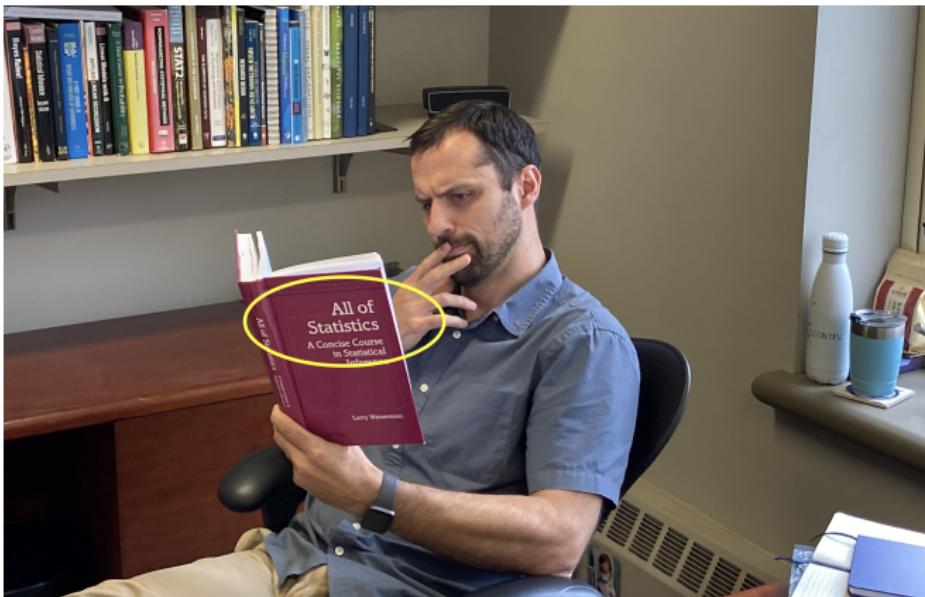


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- “data-ing?”
- that wasn’t in the book...

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- [checks list of participants for “grammarian-in-residence”]

“Data...ing?”

- I'm usually not one to “verb” my nouns (then use as a gerund)
- [*checks list of participants for “grammarian-in-residence”*]
- but I've heard this kind of thing happens on Twitter

ADULTING

What Is the Meaning of Adulting?



- Gerund that stems from the use of the word adult as a verb.
- Means behaving maturely or acting like an adult.
- A lighthearted term used to highlight the mundane or comical activities being mature and responsible can bring about.

grammarist.com

Adulting is a fairly new gerund that stems from the use of the word adult as a verb. A gerund is a verb form ending in -ing that acts as a noun. *Adulting* simply means behaving maturely or acting like an adult.

Figure 2: image credit: Grammarist. URL:
<https://grammarist.com/new-words/adulting/>

But “Data” as a verb?

- I've heard of *data verbs*, just not “data” as a verb

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But “Data” as a verb?

- I've heard of *data verbs*, just not “data” as a verb
- Amelia McNamara helpfully pointed out (to my surprise) this too has precedent!
- Who would do such a thing?

Jer Thorp



Roman Makhmutov

Jer Thorp is an artist, a writer, and a teacher. He was the first data artist in residence at *The New York Times*, is a *National Geographic Explorer*, and served as the innovator in residence at the Library of Congress in 2017 and 2018. He lives under the Manhattan Bridge with his family and his awesome dog, Trapper John, MD. *Living in Data* is his first book. You can sign up for email updates [here](#).

Coming around. . .

- “the pair data and data-ing refers to a similar conceptualization of the relation between sample and sampling, or model and modeling, where the first is the statistical concept and the second refers to the process of engaging or reasoning with this concept.”

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Coming around. . .

- “the pair data and data-ing refers to a similar conceptualization of the relation between sample and sampling, or model and modeling, where the first is the statistical concept and the second refers to the process of engaging or reasoning with this concept.”
- *This* resonates with me. . .
- and it's starting to sound like something I've observed before

What perspective can I offer?

The birth of an academic



Figure 4: (Academic) offspring of Joan Garfield & Bob delMas enters the world (of Statistics Education)

- if any of you know me, it's probably thanks to my parents
PhD advisors Joan Garfield & Bob delMas

The birth of an academic



Figure 4: (Academic) offspring of Joan Garfield & Bob delMas enters the world (of Statistics Education)

- if any of you know me, it's probably thanks to my parents PhD advisors Joan Garfield & Bob delMas
- there's plenty more to my upbringing before I ever got involved with Statistics Education, including lots that has almost nothing to do with academia!

Rebellious phase

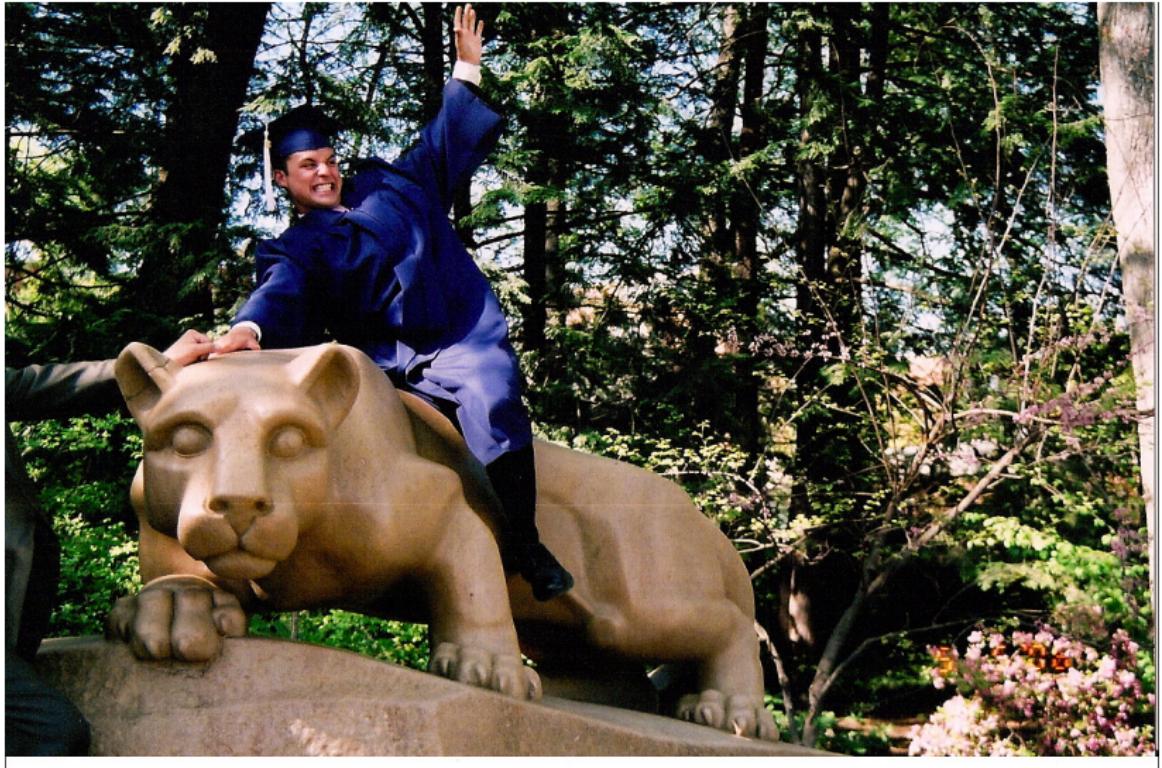


Figure 5: Who knows...

Social life



Figure 6: Sneaking onto the football field with a friend.

My actual Mum & Dad



Figure 7: Marian & Don Beckman

Got an education. . .



Getting more serious. . .

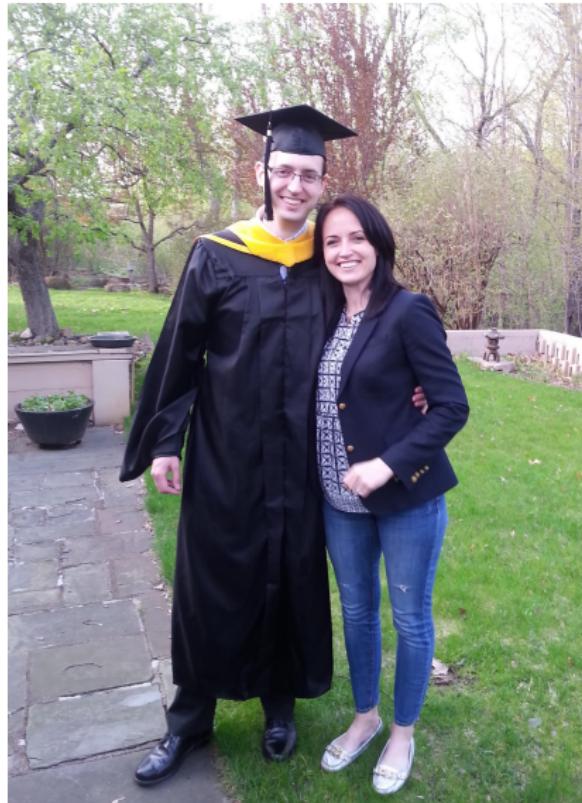


Figure 8: Met my wife in Minnesota and began a career in statistics.

Where the magic happens. . .

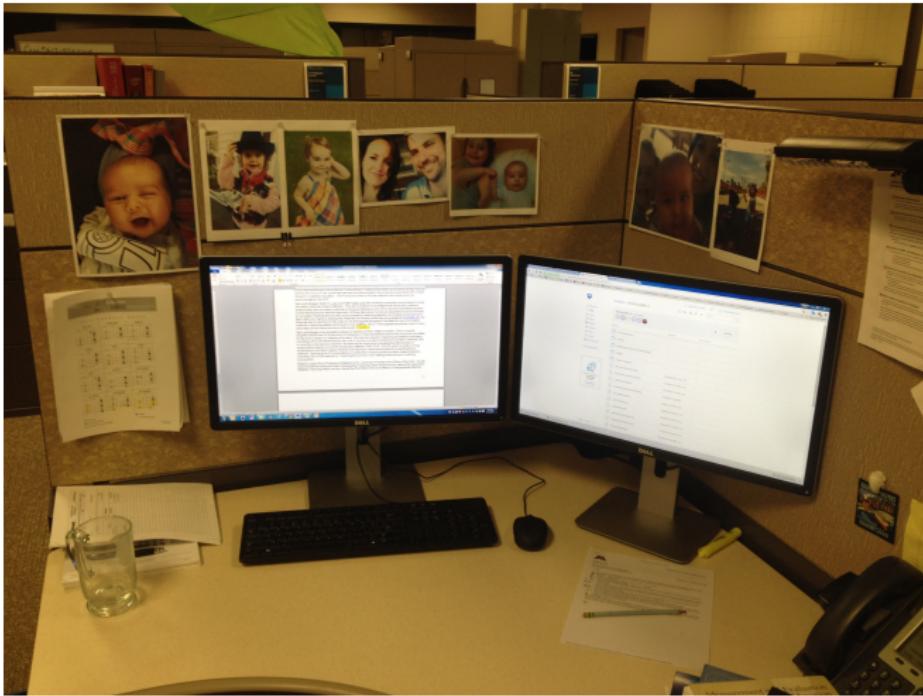


Figure 9: Working late. . .

Ecolab, Inc.



Figure 10: Image credit: Patrick Kennedy, Star Tribune²

- Started out at Ecolab working in R&D (+ Eng)
- Interned with a small team of staff statistical consultants
- Typical Data: Lots of design & analysis of experiments
- Assist teaching in-house statistics courses for Engineers, Mgmt, scientists, etc (Intro, DOE, MSA, SPC, RDSA)

²Kennedy, P., (6 Feb 2023). Ecolab now selling products at Home Depot — the first time available at retail stores. Star Tribune. URL:

[https://www.startribune.com/ecolab-now-selling-products-at-home-depot-the-](https://www.startribune.com/ecolab-now-selling-products-at-home-depot-the/)

8 yrs in Medical Technology



Figure 11: image credit:

<https://asiapac.medtronic.com/xp-en/about.html>

- Hired due to commitment to government regulators!
- Typical data: verbatim complaints from call center, manufacturing lines, clinical, sales & registration data, engineering diagnostics from in-house returned product analysis, lots more!
- Promoted to Senior Statistician; broader involvement including Quality, Manufacturing, R&D, Marketing, HR/Personnel, Six Sigma
- Regularly tasked with discussing/explaining statistical methodology and procedures to government regulators (e.g., post-market surveillance)

Nonin Medical. Inc



Figure 12: image credit: Michael Heisson³

- Senior Biostatistician (“only” statistician...)
- Internal & external collaborations (e.g., anesthesiology research, clinical trial design, etc)

³Lee, E., (4 Oct 2022). The Best Pulse Oximeter for Home Use. New York Times Wirecutter. URL: <https://www.nytimes.com/wirecutter/reviews/best-pulse-oximeter-for-home-use/>

Back to Medtronic!?

- Back to Medtronic for a lame duck session
- Goals: clean up special projects, train new statisticians (& business analysts) and help automate my own job away (!)
- Next Stop: Penn State!
- When I was a few years younger, people gave me puzzled looks when I described my background. . .

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- Life hack: I earned my PhD *while* working full-time

Personal reflections from industry

- I began to notice gaps between my expectations/assumptions for my contributions at work and the reality of my experiences on the job...
- *Expectation:* UMN Statistics Dept filled my toolbox with advanced methods & fancy models... that's what they'll expect me to do at work.
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- *Mind the gap:* At work, I generally used 10-20% of the fancy things I learned in those courses
- Lots of the fancy methods that I needed at work, I *learned* at work. This is a common refrain among professional statisticians.

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⁴Deming, W. E. (2000). *Out of the Crisis*. MIT Press.

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- **Good** reason this gap might emerge: (coming up later...)

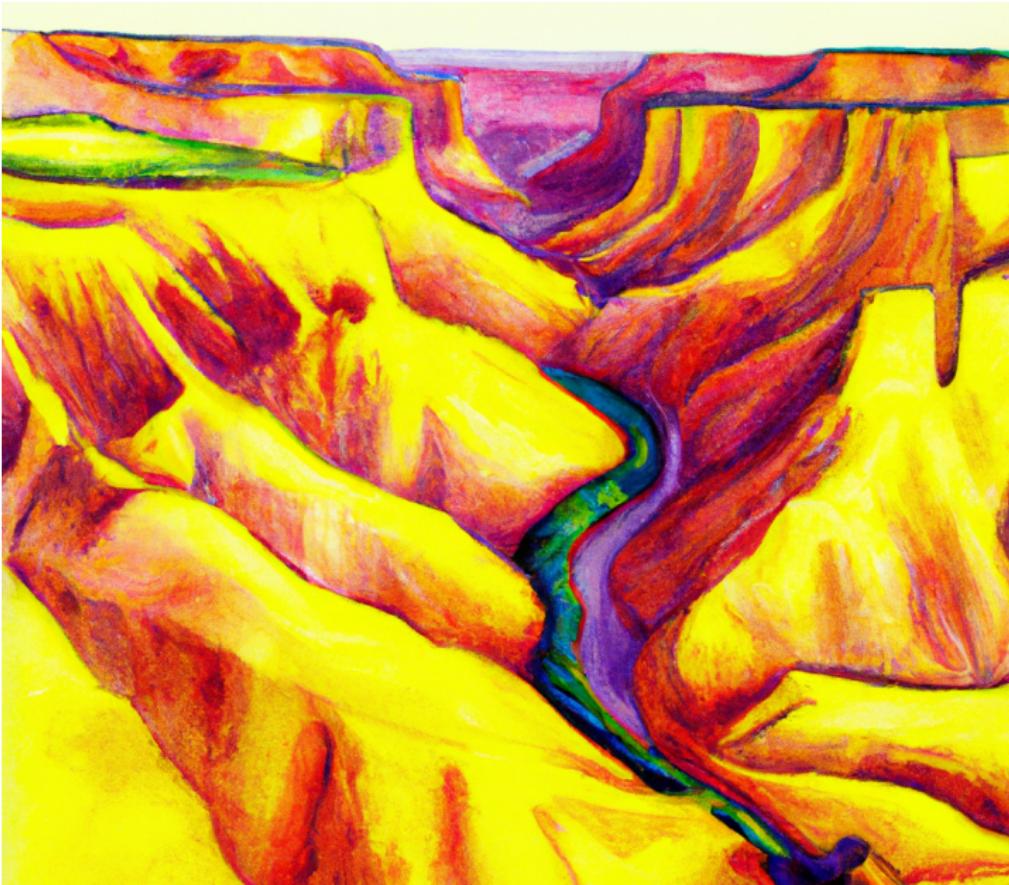
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Figure 14: image created with assistance of DALL·E 2 by Open AI

- Role of statisticians at work
- Public perception of Statistics
- Student perception of EDA
- Opportunities for research

Mind the gap: In the public

statistics vs Statistics

Mind the gap: EDA

Perceived value vs potential contribution of EDA⁵

⁵Exploratory Data Analysis

Mind the gap: EDA

- My solution?

Mind the gap: EDA

- My solution?
- my students need a framework for a careful EDA

Mind the gap: EDA

- My solution?
- my students need a framework for a careful EDA
- with an acronym to help remember it

EDA Framework (1st attempt)

Get in “B-E-D” with your data

- Become acquainted with the data

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EDA Framework (2nd attempt)

... not a great acronym

Let's just reuse "EDA" instead

- **Examine the data source(s):** data provenance, variable types, coding, missingness, summary statistics/plots;

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- p.s. Lonneke's work included a concise summary of literature that I think improves upon the "E" step!

Mind the gap: Opportunity for research?

Mind the gap: Statistical Thinking

International Statistical Review (1999), 67, 3, 223–265, Printed in Mexico
© International Statistical Institute

Statistical Thinking in Empirical Enquiry

C.J. Wild and M. Pfannkuch

Department of Statistics, University of Auckland, Private Bag 92019, Auckland, New Zealand

This paper had its genesis in a clash of cultures. Chris Wild is a statistician. Like many other statisticians, he has made impassioned pleas for a wider view of statistics in which students learn “to think statistically” (Wild, 1994). Maxine Pfannkuch is a mathematics educator whose primary research interests are now in statistics education. Conception occurred when Maxine asked “What is statistical thinking?” It is not a question a statistician would ask. Statistical thinking is the touchstone at the core of the statistician’s art. But, after a few vague generalities, Chris was reduced to stuttering.

Figure 15: Opening vignette from one of my all-time favorite papers.⁶

⁶Wild, C. J., Pfannkuch, M. (1999). Statistical thinking in empirical enquiry. *International Statistical Review*, 67(3), pp 223-265.

Thinking Statistically

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- *Bad reason*: management unclear what contribution statisticians offer to the organization
- **Good reason**: perhaps my colleagues recognized that *statistical thinking transfers*
- Disciplined approach to problem solving & critical thinking
- Due consideration for uncertainty, alternate explanations, and practical implications

Mind the gap: Data & Data-ing

"the pair data and data-ing refers to a similar conceptualization of the relation between sample and sampling, or model and modeling, where the first is the statistical concept and the second refers to the process of engaging or reasoning with this concept."

- So, why verb the noun??

Mind the gap: Data & Data-ing

"the pair data and data-ing refers to a similar conceptualization of the relation between sample and sampling, or model and modeling, where the first is the statistical concept and the second refers to the process of engaging or reasoning with this concept."

- So, why verb the noun??
- Maybe because a verb for the action we're describing *doesn't exist!*

What *IS* data-ing?

- Something new to be explored?

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- Something familiar by another name?

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What *IS* data-ing?

- Something new to be explored?
- Something familiar by another name?
- An intersection?
- A superset?
- What about Gapminder? Dollar Street? Factfulness?

What actions might data-ing include?

- data collection (Yannik & Susanne)
- variable creation/recognition (Amelia & Sibel)
- modeling and interpretation of data (Lucia)
- data cleaning (Many SRTL-ers)

More engaging and reasoning with data

- Andee & Michal probe evaluation of which data **needed** to achieve the scientific purposes?
- Carl & Kym evoke notions about data and empowering students to uncover rich (multivariate) stories
- Alyssa seeks to examine the interface between computational thinking and data-ing
- What if we favor an algorithmic rather than inferential “culture”?⁷
- Ronit challenges us to consider “big data-ing”

More engaging and reasoning with data

- Andee & Michal probe evaluation of which data **needed** to achieve the scientific purposes?
- Proxy variables when we encounter a gap in the available (or accessible) data to achieve the scientific purpose of our analysis—really important part of “data-ing” as an applied statistician, but these are motivated by the scientific domain
- Carl & Kym evoke notions about data and empowering students to uncover rich (multivariate) stories
- Alyssa seeks to examine the interface between computational thinking and data-ing
- What if we favor an algorithmic rather than inferential “culture”?⁷
- Ronit challenges us to consider “big data-ing”

⁷Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. In: Meta Group.

How well-defined is “data”

- Is “messy” data well-defined?
 - any deviation from tidy data⁸?
 - Amelia & Kym discuss intuition of data cards
- What is “big data”?⁹
 - Volume? Velocity? Variety?¹⁰
 - Does “messier” make it “bigger”
 - Is the distinction absolute or relative?
 - how will this make “big data-ing” different?
- Jill & Lonneke discuss consuming and evaluating evidence—and implications of data-ing when engaged with forms of evidence more broadly conceived than has been typical for classical data analysis

⁸Wickham, H. (2014). Tidy data. *Journal of Statistical Software*, 59(10). DOI: 10.18637/jss.v059.i10

⁹Kitchin, R., & McArdle, G. (2016). What makes Big Data, Big Data? Exploring the ontological characteristics of 26 datasets. *Big Data & Society*, 3(1).

¹⁰Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. In: Meta Group.

RESTAURANT FORUM

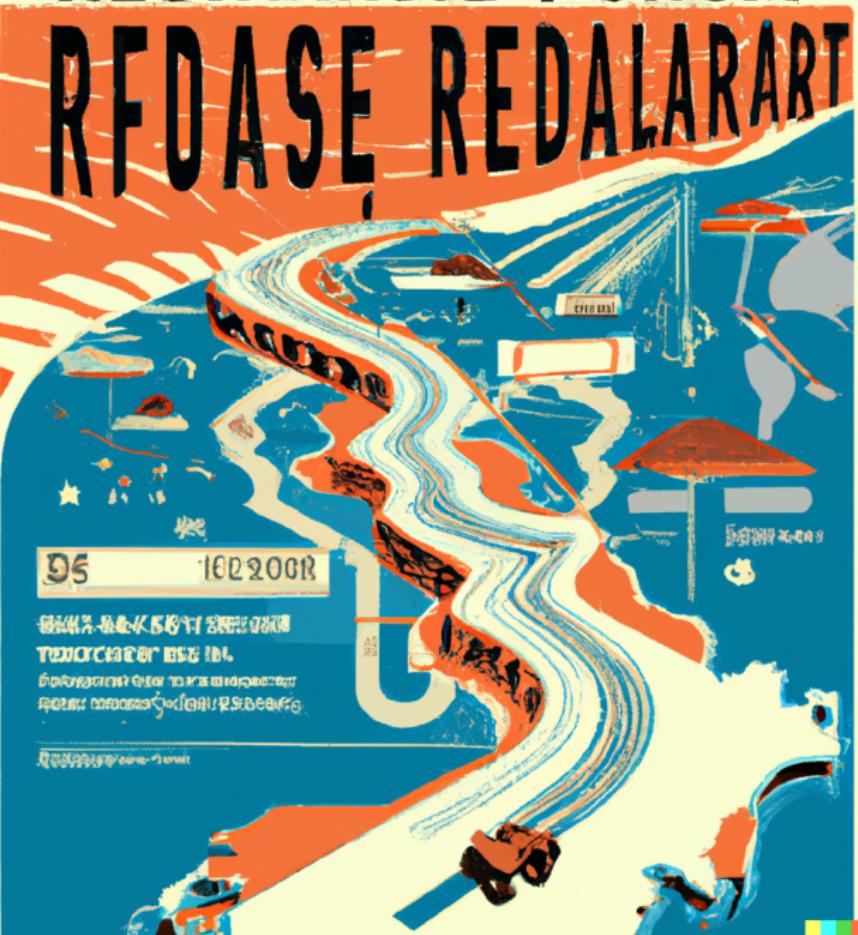
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Restauranterne
Tilskud til restauranterne
Rabatter til restauranterne
Mere om restauranterne

Restauranterne



References

- Batty, M. (2015). Data about cities: Redefining big, recasting small. Paper prepared for the Data and the City workshop, Maynooth University, 31 August–1 September 2015. URL: <http://www.spatialcomplexity.info/files/2015/08/Data-Cities-Maynooth-Paper-BATTY.pdf>
- Breiman, L. (2001). Statistical modeling: The two cultures. *Statistical science*, 16(3), 199-231.
- Deming, W. E. (2000). *Out of the Crisis*. MIT Press.
- Kitchin, R., & McArdle, G. (2016). What makes Big Data, Big Data? Exploring the ontological characteristics of 26 datasets. *Big Data & Society*, 3(1).
- Laney, D. (2001) 3D data management: Controlling data volume, velocity and variety. In: Meta Group. URL: <https://studylib.net/doc/8647594/3d-data-management--controlling-data-volume--velocity--an...>
- Tukey, J. (1977). *Exploratory Data Analysis*. Vol 2.
- Wickham, H. (2014). Tidy data. *Journal of Statistical Software*, 59(10). DOI: 10.18637/jss.v059.i10
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