"Garbage In, Garbage Out" Revisited: Labeling and Dataification Practices Across Disciplines

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CIC 2022, Virtual | slides at tinyurl.com/GIGOCIC

Who am I? An interdisciplinary nomad concerned with data and its discontents, in many contexts

- **Three degrees from weird "make your own degree" programs:**
  - B.A. Humanities (Univ of Texas at Austin)
  - M.A. Communication, Culture, and Technology (Georgetown Univ)
  - Ph.D Information (UC-Berkeley School of Information)
- **Core training: history and philosophy of science and technology; anthropology; information science; natural language processing**
- **Ph.D on the social-technical construction of knowledge in Wikipedia**
- **Four years as "staff ethnographer" at UC Berkeley Institute for Data Science, studying various"tribes" of data scientists and developers**
- **Now joint faculty in Communication and Data Science at UC San Diego, teaching required graduate "Data Ethics and Society" class**

A universal concern: dataification

- A concept from Science & Technology Studies (STS), an interdisciplinary field that takes sci & tech as its object of research (see Cukier and Mayer-Schonberger 2013)
- How is the world, in all its complexity & richness, reduced to data?
- Measurement methods and data labeling are crucial, but are seen as 'boring' and not worth discussing --- just give us results/AUC!
- Students love data science as a degree because they can work across many domains, disciplines, contexts, application areas, etc.
    - But they mostly re-use data collected by others, with little understanding of how data was collected and its limitations

Data: raw, cleaned, and cooked

Dataification: the map is not the territory

“All models are wrong, but some are useful” - George Box

“On Inexactitude in Science” by Jorge Luis Borges:

> “...In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guild struck a Map of the Empire whose size was that of the Empire, and which coincided point for point [...]
>
> In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography”

The world is changing, but how we dataify the world is changing faster --- and with little documentation

High-stakes example: Predictive policing, using historical crime data to model future crime: where, when, and (even more controversially) by whom

Ethical and methodological issues in using past generations' outcomes to predict the current generation's futures, especially in predicting recidivism for bail decisions

"Crime data" is not a full or representative sample of all crime; many biases:

- Institutional biases: Where has the police department sent officers to patrol the most? Are certain kinds of kinds of crimes or activities deemed to be a higher priority than others? Ex: drugs vs auto theft
- Individual biases: When officers are on patrol in a neighborhood, which officers focus on certain kinds of "suspicious" people or activities more? Which residents report crime, and which reports are investigated?
- In San Diego, *Shotspotter* microphone-based gunshot detection system is only in 4 low-income minority neighborhoods; >20% false positive rate; 'activations' send officers racing to a neighborhood

Our **Garbage In, Garbage Out Revisited** Project

“On two occasions I have been asked, "...Mr. Babbage, if you put into the machine wrong figures, will the right answers come out?" ... I am not able rightly to apprehend the kind of confusion of ideas that could provoke such a question.”

— Charles Babbage (*1864)*

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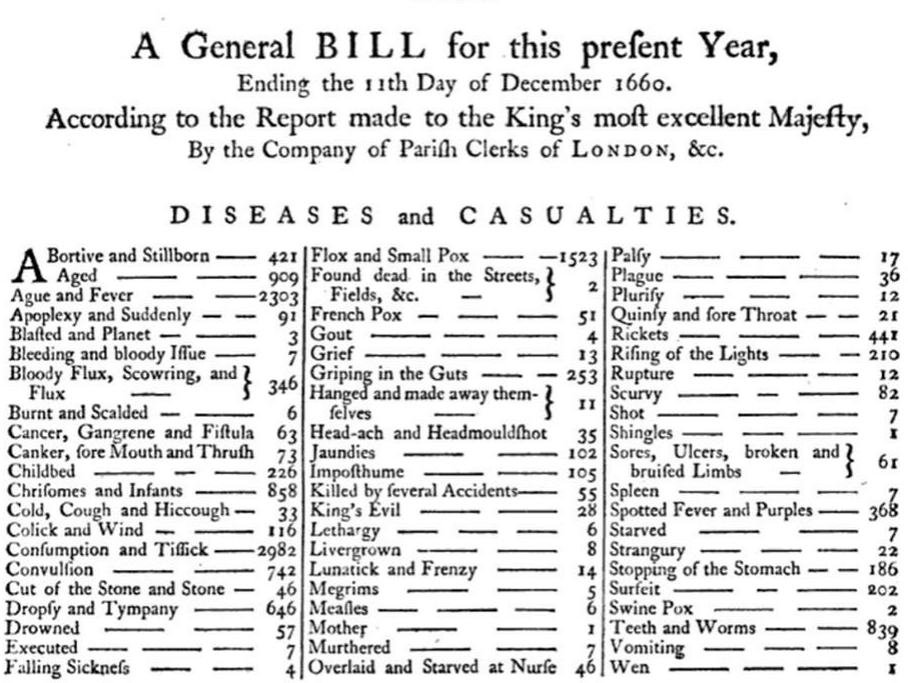
Causes of death in London, 1660:

- People used to die of grief, lunacy, planet
- These were the most empirical and data-driven proto-scientists of their day
- How will future generations look at us?



1660.

A General BILL for this preſent Year,

Ending the 11th Day of December 1660.

According to the Report made to the King's moſt excellent Majeſty,

By the Company of Pariſh Clerks of LONDON, &c.

DISEASES and CASUALTIES.

Abortive and Stillborn	421	Flox and Small Pox	1523	Palſy	17
Aged	909	Found dead in the Streets, Fields, &c.	2	Plague	36
Ague and Fever	2303	French Pox	51	Plurify	12
Apoplexy and Suddenly	91	Gout	4	Quinſy and ſore Throat	21
Blaſted and Planet	3	Grief	13	Rickets	441
Bleeding and bloody Iſſue	7	Griping in the Guts	253	Riſing of the Lights	210
Bloody Flux, Scowring, and Flux	346	Hanged and made away themſelves	11	Rupture	12
Burnt and Scalded	6	Head-ach and Headmouldſhot	35	Scurvy	82
Cancer, Gangrene and Fiſtula	63	Jaundies	102	Shot	7
Canker, ſore Mouth and Thruſh	73	Impoſthume	105	Shingles	1
Childbed	226	Killed by ſeveral Accidents	55	Sores, Ulcers, broken and bruiſed Limbs	61
Chriſomes and Infants	858	King's Evil	28	Spleen	7
Cold, Cough and Hiccough	33	Lethargy	6	Spotted Fever and Purples	368
Colick and Wind	116	Livergrown	8	Starved	7
Conſumption and Tiſſick	2982	Lunatick and Frenzy	14	Strangury	22
Convulſion	742	Megrims	5	Stopping of the Stomach	186
Cut of the Stone and Stone	46	Meaſles	6	Surfeit	202
Dropſy and Tympany	646	Mother	1	Swine Pox	2
Drowned	57	Murthered	7	Teeth and Worms	839
Executed	7	Overlaid and Starved at Nurſe	46	Vomiting	8
Falling Sickneſs	4			Wen	1

Our **Garbage In, Garbage Out Revisited** Project

Two meta-research studies about how applied ML papers discuss their training data and data labeling practices (if at all), including supplemental materials:

Study of NLP-based ML application papers using data from Twitter:

Geiger, R. S., Yu, K., Yang, Y., Dai, M., Qiu, J., Tang, R., & Huang, J. (2020). “Garbage in, garbage out? Do machine learning application papers in social computing report where human-labeled training data comes from?” In *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency* (pp. 325-336).

Study of ML application papers across disciplines:

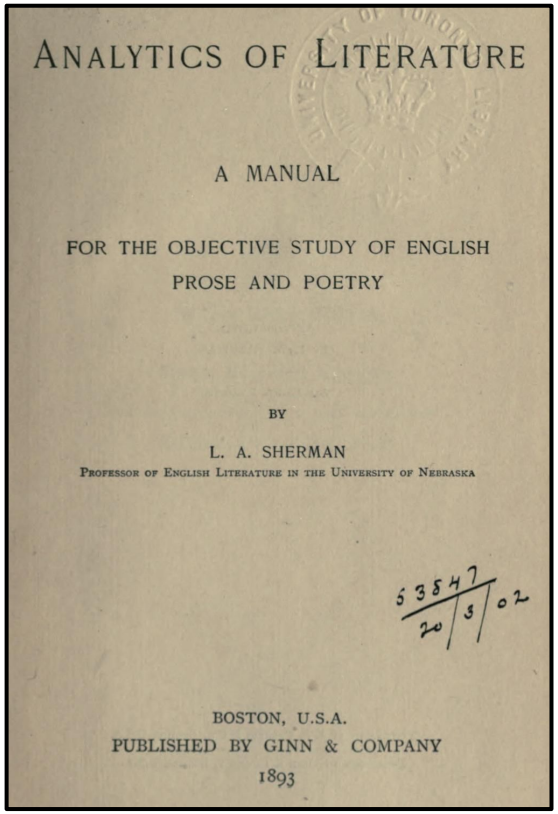
Geiger, R. S., Cope, D., Ip, J., Lotosh, M., Shah, A., Weng, J., & Tang, R. (2021). “‘Garbage in, garbage out’ revisited: What do machine learning application papers report about human-labeled training data?” *Quantitative Science Studies*, 2(3), 795-827.

The GIGO papers in four bullet points:

- Many of the ethical issues that arise in machine learning applications can be traced back to the quality of training data.
- The way training data is labeled by humans is often a form of structured content analysis, which has established best practices in the social sciences and humanities (also in life & ecosciences)
- RQ: How many applied ML papers report following best practices?
- A: Few, and varies substantially, showing need for more focus on data labeling practices in ML education, evaluation, and regulation.

Data labeling: structured content analysis

An established quantitative method in the humanities and social sciences, used by generations of researchers.


ANALYTICS OF LITERATURE

A MANUAL

FOR THE OBJECTIVE STUDY OF ENGLISH PROSE AND POETRY

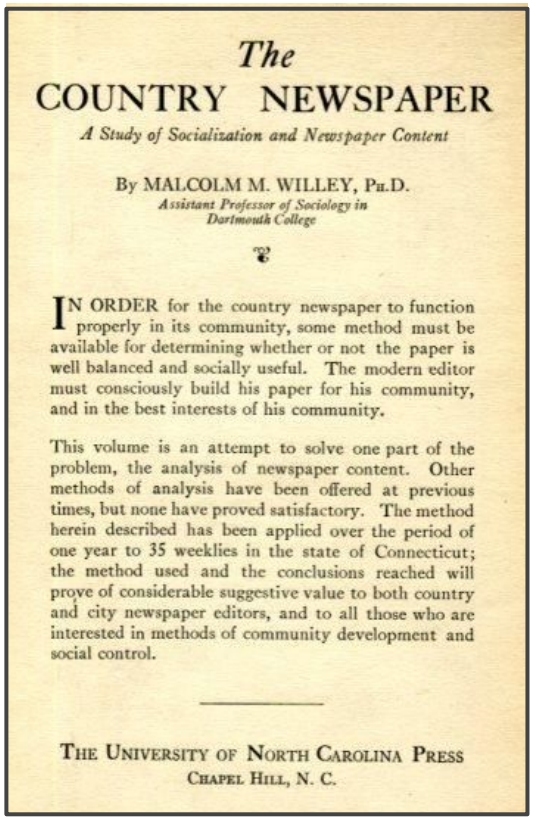
BY

L. A. SHERMAN

PROFESSOR OF ENGLISH LITERATURE IN THE UNIVERSITY OF NEBRASKA

BOSTON, U.S.A.
PUBLISHED BY GINN & COMPANY
1893

Sherman (1893)


The
COUNTRY NEWSPAPER

A Study of Socialization and Newspaper Content

By MALCOLM M. WILLEY, Ph.D.
Assistant Professor of Sociology in Dartmouth College

IN ORDER for the country newspaper to function properly in its community, some method must be available for determining whether or not the paper is well balanced and socially useful. The modern editor must consciously build his paper for his community, and in the best interests of his community.

This volume is an attempt to solve one part of the problem, the analysis of newspaper content. Other methods of analysis have been offered at previous times, but none have proved satisfactory. The method herein described has been applied over the period of one year to 35 weeklies in the state of Connecticut; the method used and the conclusions reached will prove of considerable suggestive value to both country and city newspaper editors, and to all those who are interested in methods of community development and social control.

THE UNIVERSITY OF NORTH CAROLINA PRESS
CHAPEL HILL, N. C.

Willey (1923)

Structured content analysis best practices:

"a systematic and replicable method" (Riff, Lacy, and Frederick 2013)

1. Define a "coding* scheme" with procedures, definitions, and examples.
2. Recruit and train multiple "coders" (or "annotators", "labelers", or "reviewers") with the coding scheme.
3. Have coders independently code at least a portion of the same items, then calculate "inter-annotator agreement" or "inter-rater reliability."
4. Define and follow a process of "reconciliation" for disagreements, e.g. majority rule, talk to consensus, expert/leader decides.
5. Modify coding scheme, training, and/or reconciliation as needed.

* We've been using "coding" to describe this work since before punchcards existed!

Our data labeling/annotation process (study 1)

Labelers: Five undergraduate students working for course credit were trained, then independently reviewed each paper

Reconciliation: Disagreement reconciled by talking to consensus, facilitated by the team leader, who made the final decision.

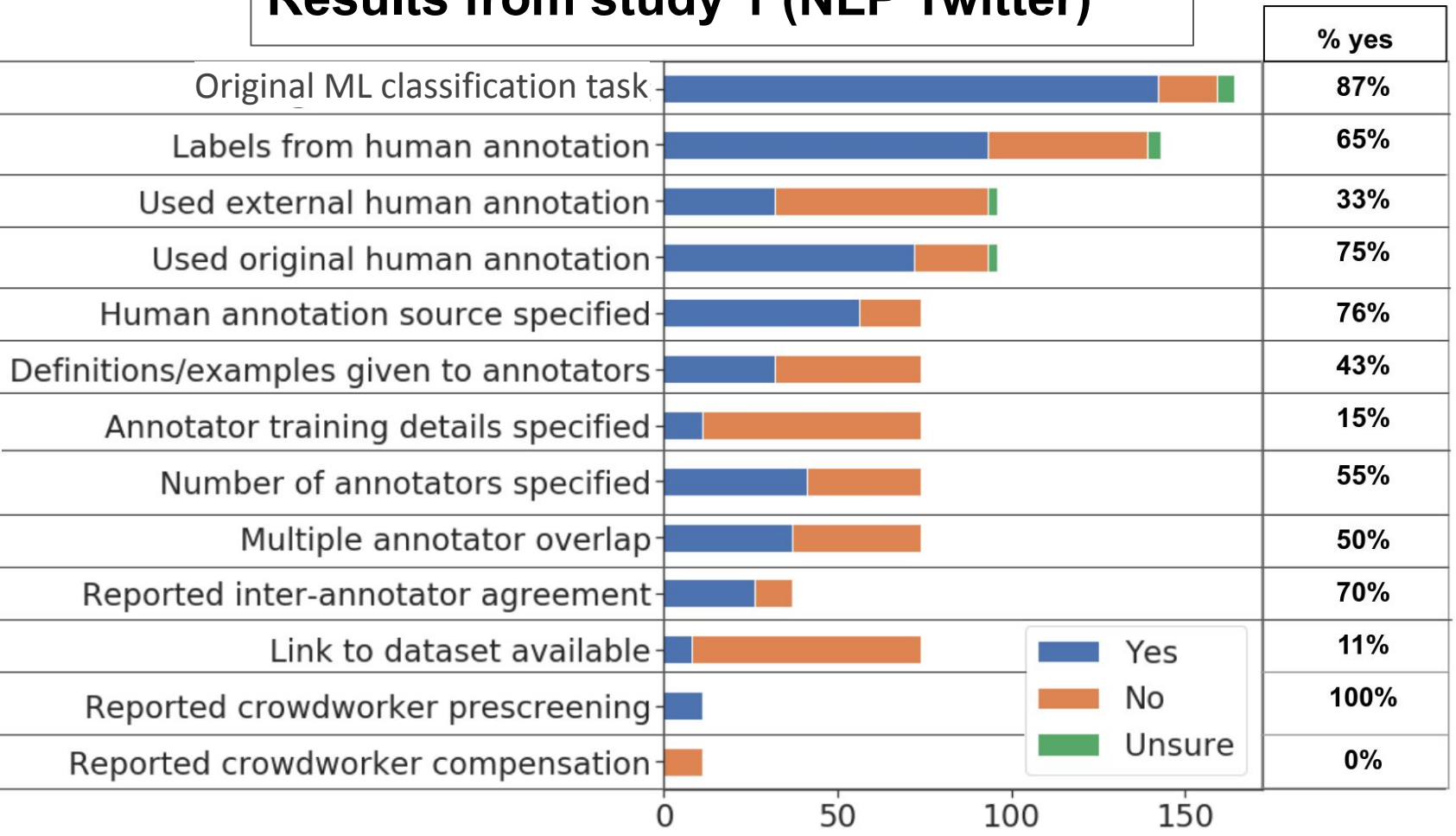
Iteration: Two rounds of labeling, after low agreement rates were found in round 1. Schema and instructions were revised and validated

Agreement: mean total agreement across all questions was 84.4%.

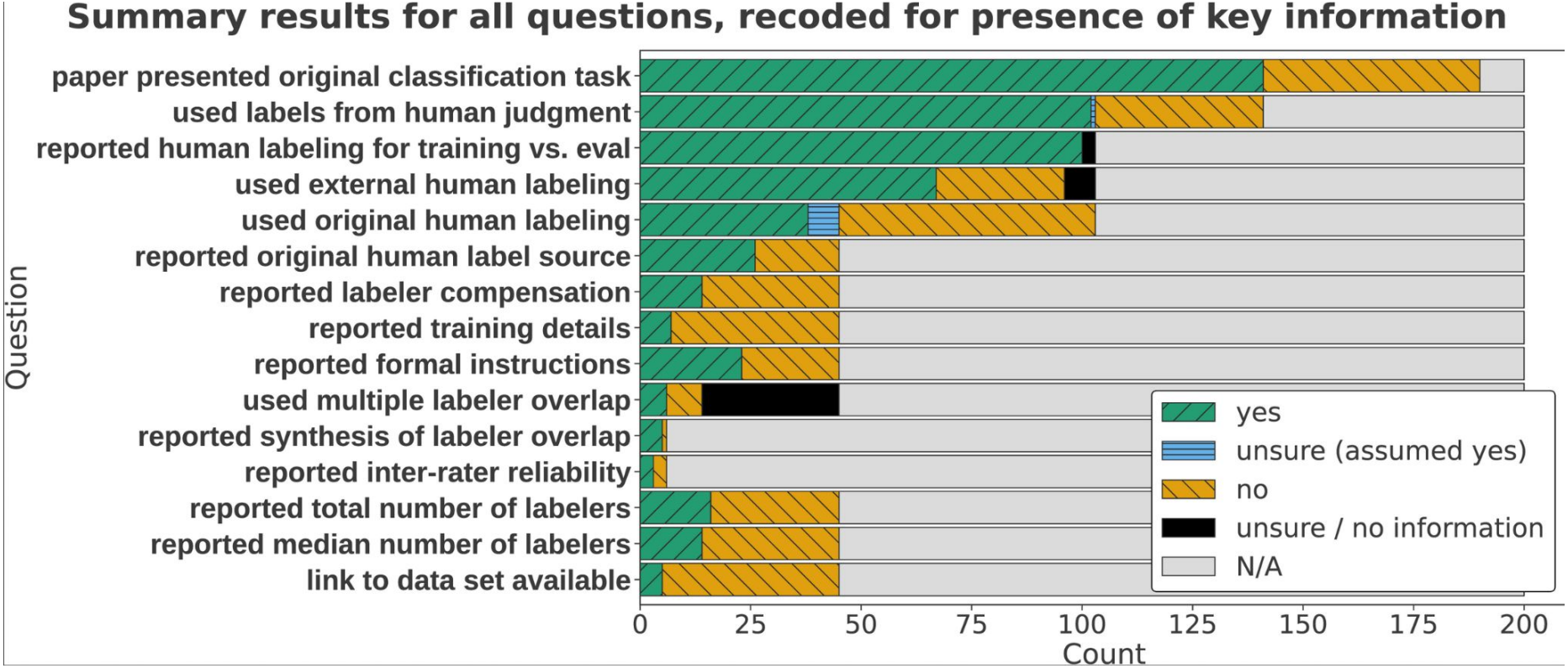
Questions we asked:

1. Is the paper presenting an original ML classification task?
2. Are the training data labels from human annotation?
3. Were the human labels from original labeling, an external dataset, or both?
4. Who labeled the dataset? (e.g. authors, turkers, experts)
5. Were the number of human annotators specified? (either total or per item)
6. Were instructions, formal definitions, or examples given to annotators?
7. Did annotators receive interactive training (beyond instructions/schema)?
8. For projects using crowdworkers, were annotators pre-screened?
9. Did multiple humans independently annotate every item (or some items)?
10. If so, were inter-annotator agreement metrics reported?
11. For projects using crowdworkers, was compensation reported?
12. Is there a link to the dataset available in the paper?

Results from study 1 (NLP Twitter)



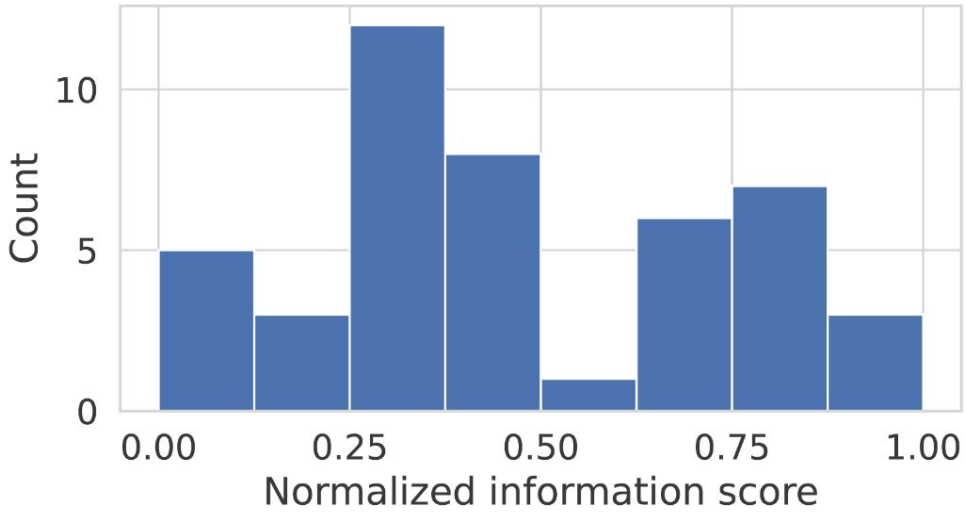
Results from study 2 (across disciplines)



Distribution of information scores

What proportion of information needed to reproduce the study was reported?

A roughly bi-modial distribution suggests there are two populations of papers/studies.



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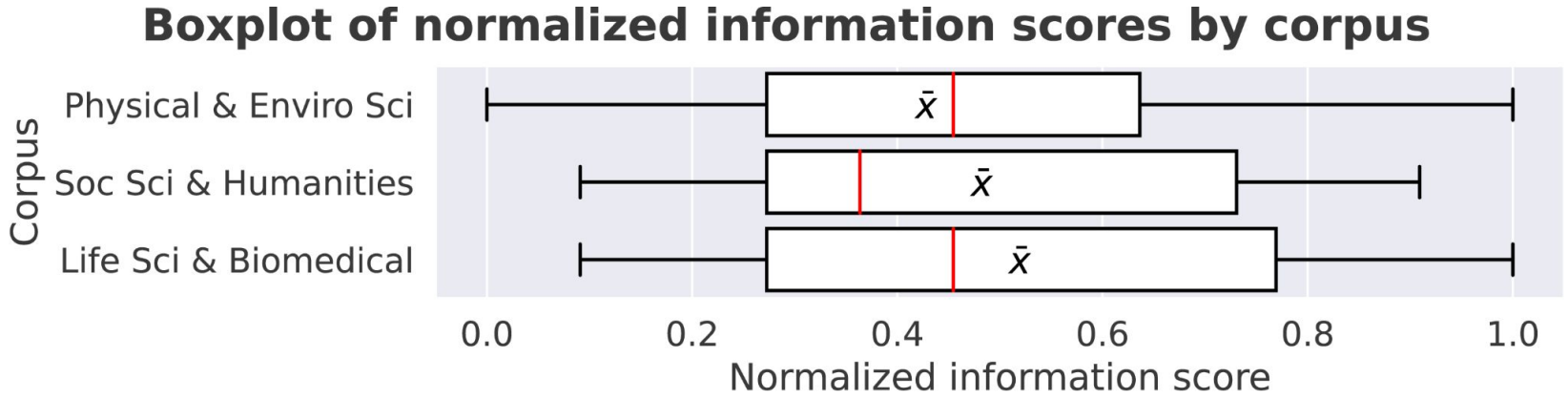

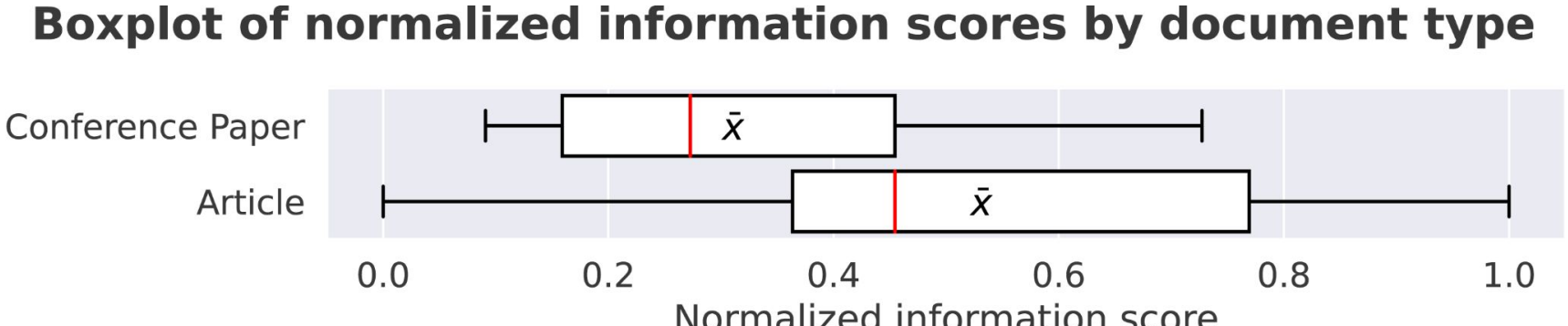

Panel questions

Q2: Do the changes in the world affect bias and fairness in data and algorithms?

Yes, especially when our ways of measuring the world change as the world itself is also changing --- a recursive feedback loop

Q3: How do we adapt to unpredictable and uncontrollable evolution when considering bias and fairness?

Whatever the answer, we need to get much better at:

- Documenting our data collection, cleaning, and cooking
- Sharing that documentation with others, especially if it is messy
- Rewarding the 80% of data work that takes place before analysis

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