How Data Scientists Review the Scholarly Literature

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Sarah Akbar, Andre Kenneth Chase Randall, Narges Mahyar

University of Massachusetts Amherst
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Data science is booming

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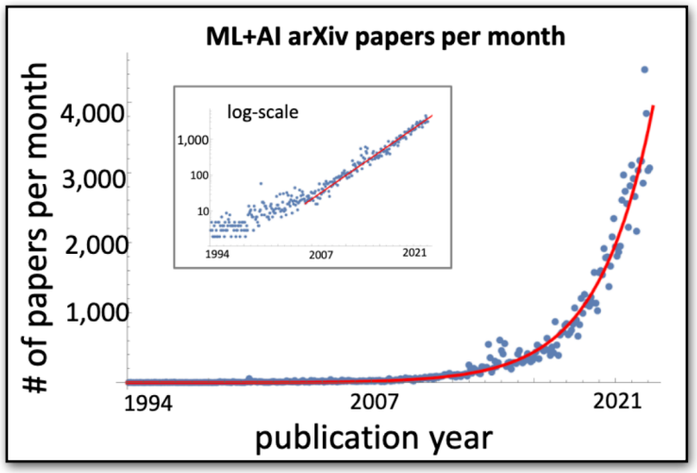

✦ Papers double every two years[1]

[1] Krenn, Mario, et al. "Predicting the Future of AI with AI: High-quality link prediction in an exponentially growing knowledge network." arXiv, 2022

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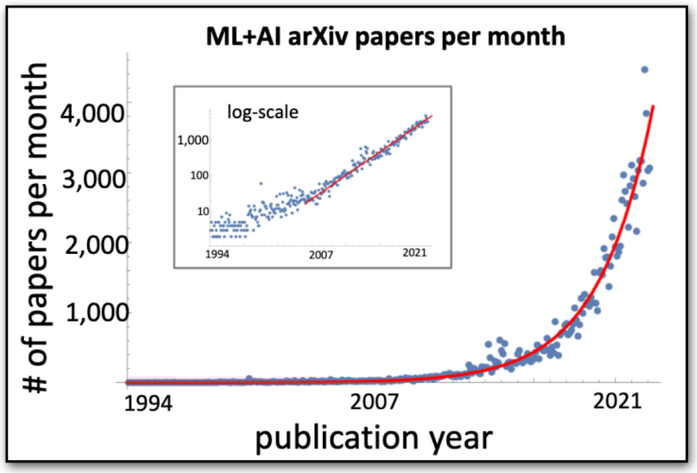

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SKYNET TODAY
Putting AI News In Perspective

- A rise in tools intended to help data scientists keep up with the literature

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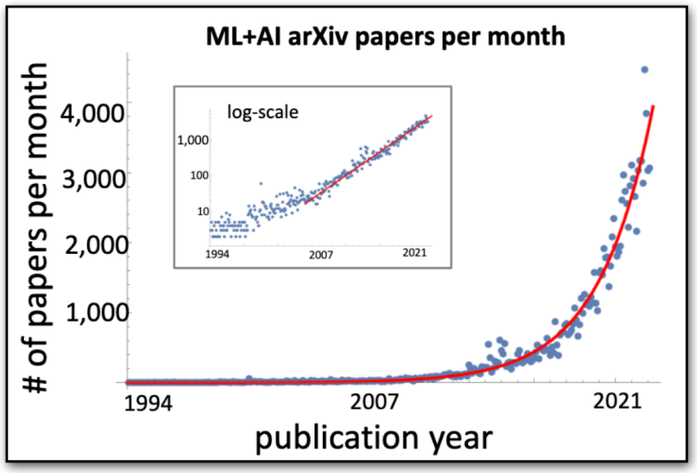

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✦ Competitions to predict the research data science research frontier[1]

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Data scientists are overwhelmed!

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r/MachineLearning

Posts

Posted by u/beezlebub33 5 months ago

272

[D] Giving Up on Staying Up to Date and Splitting the Field

Discussion

Does anyone else feel completely unable to keep up with machine learning and AI in general? I have my sub-sub-field and I do my work in (applied, mostly) and I read those papers, but I at least try to keep somewhat up to date on the entire topic of machine learning.

I mean, at this point I understand Transformers and related, and I kind of understand Latent Diffusion Models and Graph Neural Networks but not enough to use them, but I've lost the bubble on what's happening in deep reinforcement learning. I'm sure AlphaTensor is great, but I just don't have the time and energy.

I'm dreading NeurIPS and trying to figure out what people are talking about. I am wondering if ML needs to do what physics did a while ago, and just give up on trying to understand all of it.

I have a relative who does physics of solar cells (something about hot carriers and hyperfine states???) who doesn't understand what the relativity people he went to undergraduate with are talking about. They go to different conferences now.

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A consequent slowdown in scientific progress (?)

Chu, Johan SG, and James A. Evans. "Slowed canonical progress in large fields of science." PNAS, 2021

A consequent slowdown in scientific progress (?)

PNAS

Slowed canonical progress in large fields of science

Johan S. G. Chu[a,1] and James A. Evans[b,c,d]

[a]Kellogg School of Management, Northwestern University, Evanston, IL, 60208; [b]Department of Sociology, University of Chicago, Chicago, IL, 60637; [c]Knowledge Lab, University of Chicago, Chicago, IL, 60637; and [d]Santa Fe Institute, Santa Fe, NM, 87501

Edited by Kenneth W. Wachter, University of California, Berkeley, CA, and approved August 25, 2021 (received for review December 8, 2020)

✦ Peer reviewers struggle to recognize and understand novel ideas

Chu, Johan SG, and James A. Evans. "Slowed canonical progress in large fields of science." PNAS, 2021

Exploring data scientists reviewing the literature

Exploring data scientists reviewing the literature

- ✦ Data scientists[1]

- ✦ Literature reviews[2]

[1] Crisan et. al. "Passing the data baton: A retrospective analysis on data science work and workers." IEEE Transactions on Visualization and Computer Graphics, 2020

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Exploring data scientists reviewing the literature

- Data scientists[1]
  - Individuals trained in computer science, statistics, and application specific disciplines e.g. economics or biology
  - Engaged in data work, applied engineering, and research

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- Literature reviews[2]
  - A learning process spanning information seeking, sensemaking, and composition
  - Obtaining research literature, forming a synthesized understanding of the gathered data, and presentation of this information

[1] Crisan et. al. "Passing the data baton: A retrospective analysis on data science work and workers." IEEE Transactions on Visualization and Computer Graphics, 2020

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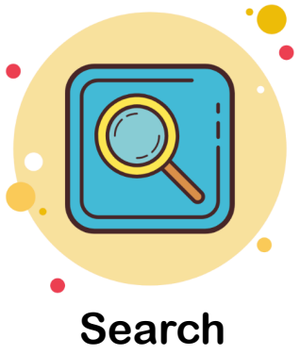

Search

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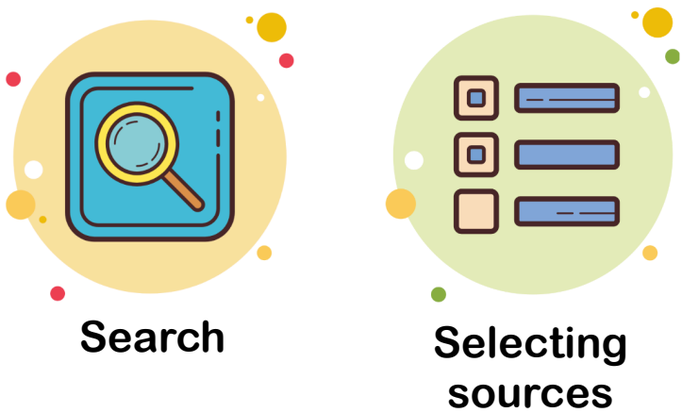

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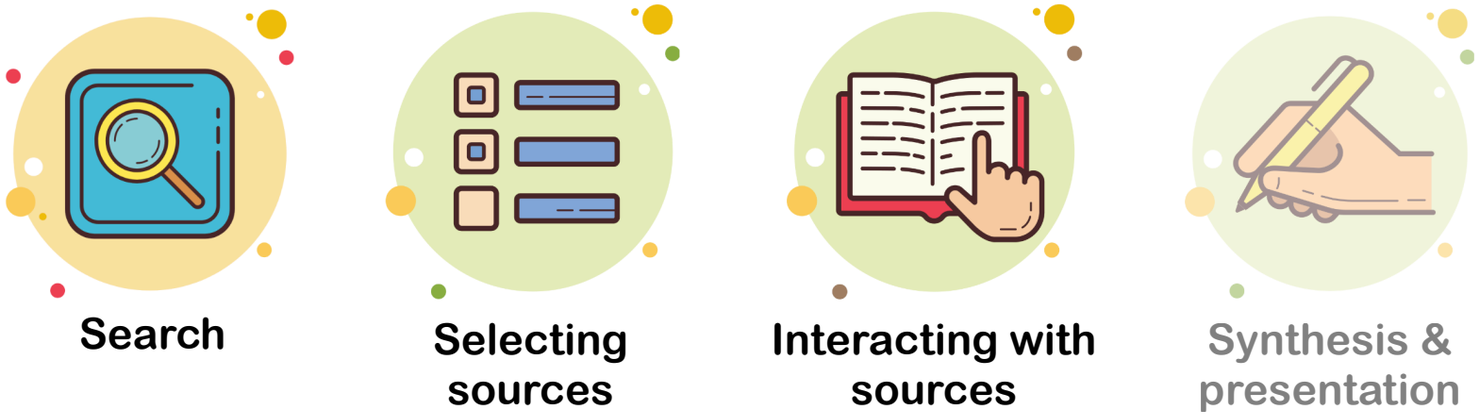

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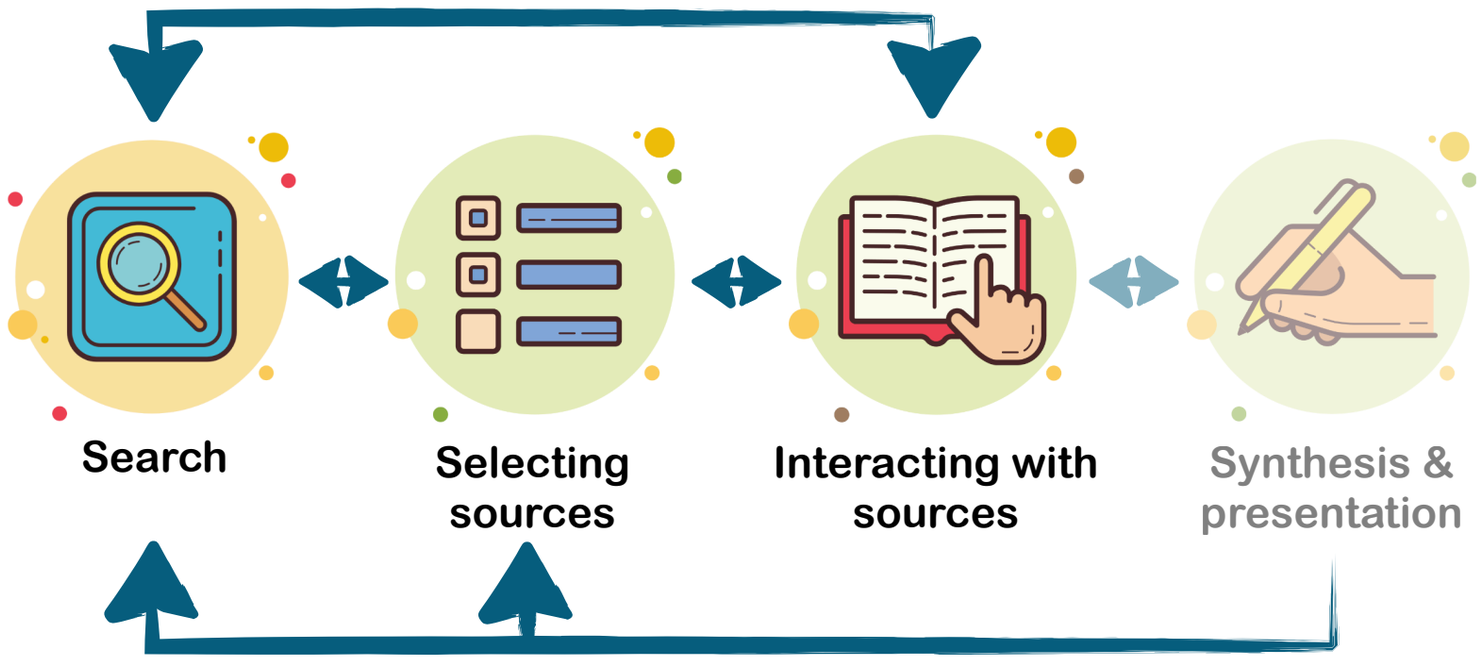

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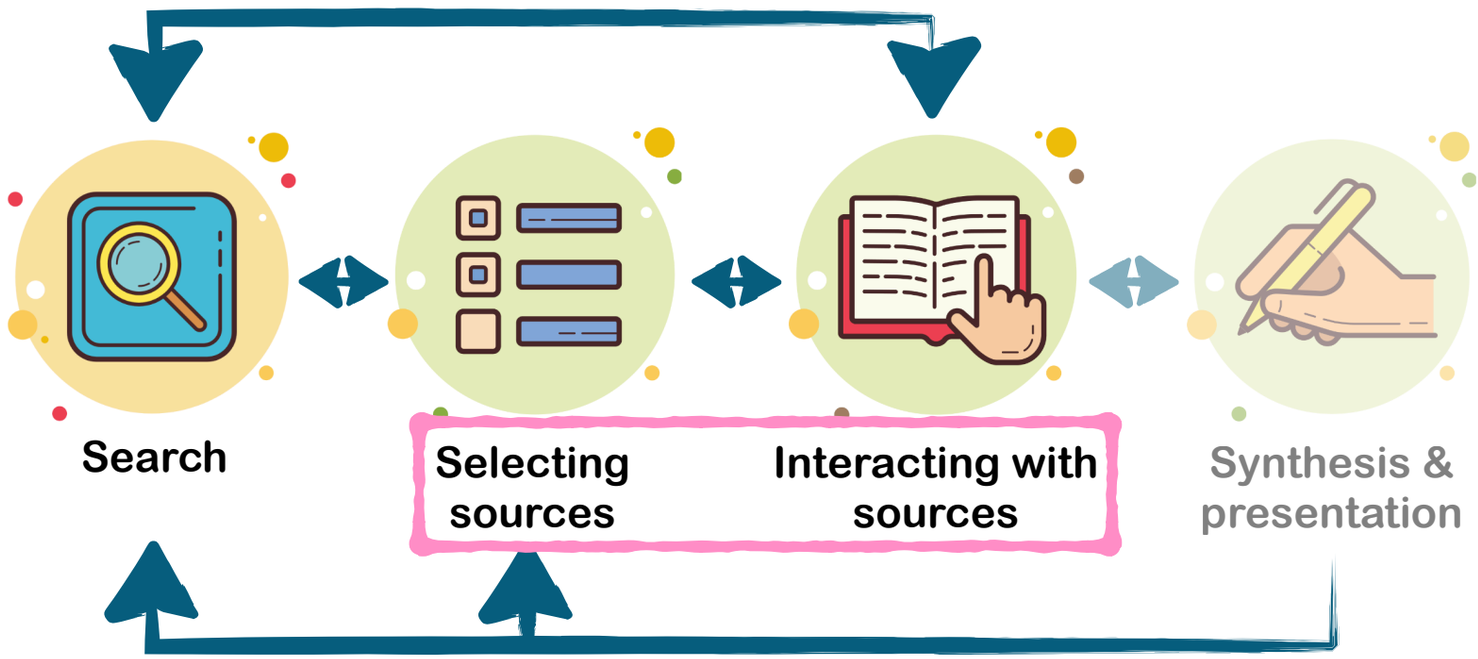

✦ Examining the activities around search; skimming, reading, and synthesis

Remainder of the talk

- ✦ Study goals and motivations
- ✦ Our partcipants
- ✦ Methods for the study & analysis
- ✦ Results
- ✦ Implications

Study Participants

- ✦ 20 participants; self-id as data scientists
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✦ Noted pronouns: 11 he/him, 9 she/hers, 2 they/them

Study & Analysis Methods

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- Semi-structured interviews
- Encouraged to discuss all interactions with literature

- Think-aloud observation
- Participant explores literature

1 hour x 20

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- ✦ Axial coding; 3 authors
- ✦ Agreement α: 0.92
- ✦ Thematic analysis

3 months

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"Recall **a literature review you conducted in the past**. Imagine you were re-starting this process and show us how you went through the literature review."

OR

"Imagine you are interested **in finding and documenting the latest work on a topic of your interest**, show us how you go about this process."

OR

"Imagine you are **planning future work on a problem you are interested in**, conduct the literature review to help plan your future work"

Remainder of the talk

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Results

- ✦ Why do data scientists access the literature?
- ✦ How do they access the literature?
- ✦ How do they select papers?
- ✦ What challenges do they face in reading papers?
- ✦ How do they lean on social ties?

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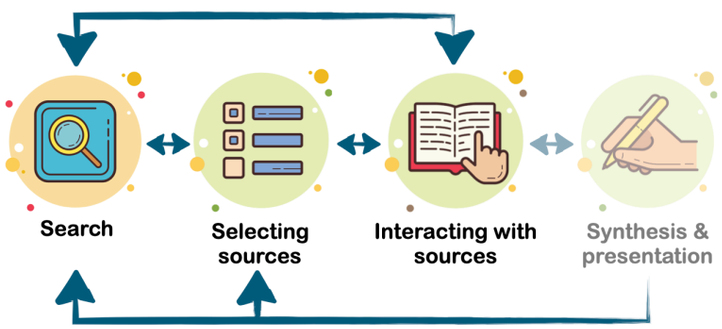

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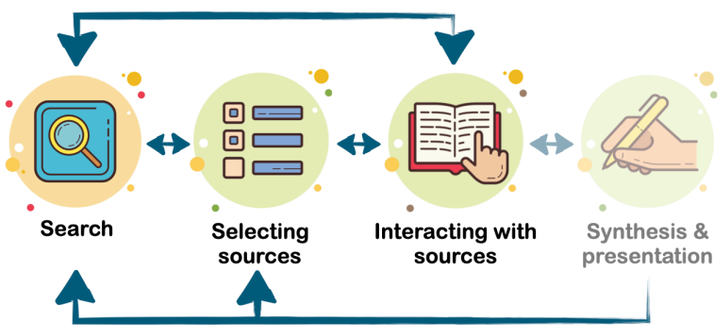

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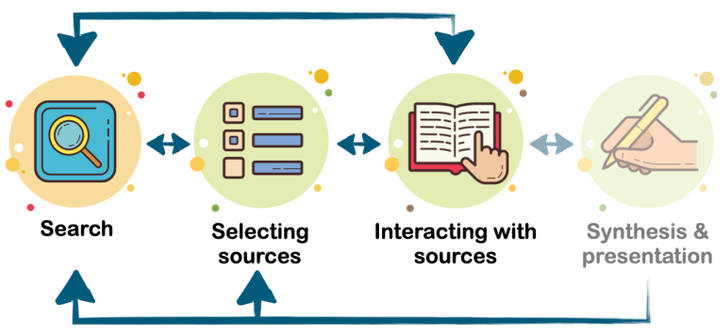

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- ✦ Passively following a discipline

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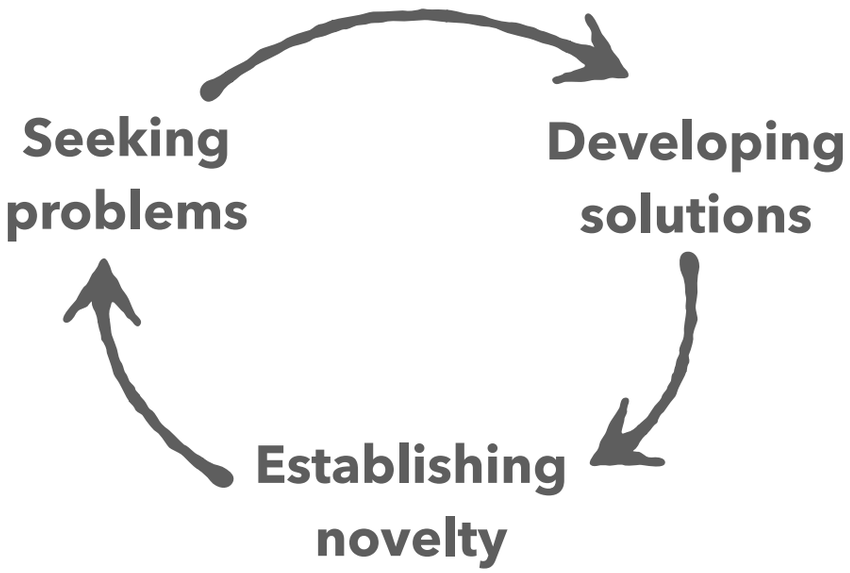

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"I'm probably heavily **in my own bubble of papers** ... if I'm working on hate speech, most of my recommendations will be very computer science based but maybe there's relevant stuff in social science that I'm probably never going to come across." - P11.

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> "In grad school a **professor synthesizes** these things and says hey, **this is the main theme of all these papers**. When that information is there for you, it tells you what to expect otherwise you're spending a lot of time and don't understand **how different it is from previous papers**" - P7.

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- Understanding salient differences between similar items
  - Users understand similar item variants in terms of their differences or aligned to time e.g. code snippets[1]

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[1] Srinivasa Ragavan, Sruti, et al. "Foraging among an overabundance of similar variants." CHI, 2016

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  - ✦ A mismatch from information scent

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People do a lot of **re-branding**, sometimes a lot of ideas are not very new but the motivation section is like poetry and when you read the details you feel [its] not what they are claiming they do. ... [or] **exaggerating their contribution** and not meeting the expectation in their experiments. So identifying those trends from papers is very important." - P19



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- ✦ Understanding the hidden details of papers through code

> [I ask authors if] there is any publicly available code for what you're doing. Because many of these papers look well on paper but then its **unclear how to implement them**. Or its **unclear which specific hyperparameter choices they made**. - P16

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- ✦ Understanding the hidden details of papers through code
- ✦ Understanding the math on display in papers with blogs, code, and talks
  - ✦ Problem with disciplinary norms

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> In writing for niche audiences it requires having to show that [an idea] is important or useful and often that means that they will add equations or theorems [for an idea] that really is not as complicated ... **if there's a lot of math or if it's hard to understand it must be impressive**. - P5

How do data scientists lean on social ties?

- ✦ Seeking recommendations, collaboratively brainstorming, and making sense of papers with
  - ✦ Peers in person
  - ✦ Peers in online forums
- ✦ Leveraging engagement with authors
  - ✦ In direct communicaton
  - ✦ Passively through talks and forum posts

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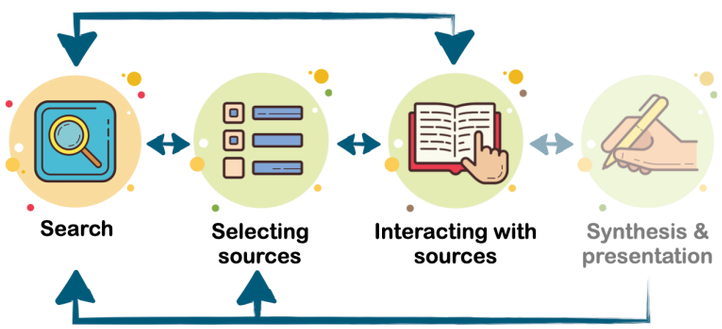

Implications

- ✦ Support cross-disciplinary access
- ✦ Faclitate reliance on close peers
- ✦ Leverage the knowledge context of papers

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- Example prior work → possible future work
- 
- Likely to span work in several related fields (IR, HCI, NLP, CSCW …)

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- ✦ Data science is a rapidly evolving and interdisciplinary field
- ✦ Data scientists operate in their own knowledge silos

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✦ Some ways forward:

✦ Verbose, interactive, conversational searches for cross domain exploration

✦ Skimming aids such as adaptive document layouts, document level FAQs, and QA - perhaps with personalization to readers

✦ Reading aids like paraphrasing documents toward different disciplinary audiences

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- ✦ But, people learn when a task is perceived as challenging[1, 2]

---

[1] Vakkari, Pertti, and Saila Huuskonen. "Search effort degrades search output but improves task outcome.", JASIST, 2012

[2] Liu, Ying-Hsang, et al. "Search Interfaces for Biomedical Searching: How do Gaze, User Perception, Search Behaviour and Search Performance Relate?." CHIIR, 2022

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- ✦ With peers, data scientists did:
  - ✦ Received recommendations, brainstormed, established credibility, read papers

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  - ✦ Received recommendations, brainstormed, established credibility, read papers
- ✦ Some ways forward:

- ✦ Sensemaking, reading, discovery in collaborative feed-readers[1, 2]

- ✦ Collaborative conversational agents aiding brainstorming[3]

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[1] Piao, Jinghua, et al. "Bringing Friends into the Loop of Recommender Systems: An Exploratory Study.", CSCW, 2021

[2] Aizenbud-Reshef, Netta, Ido Guy, and Michal Jacovi. "Collaborative feed reading in a community." ACM GROUP, 2009

[3] Avula, Sandeep, et al. "Searchbots: User engagement with chatbots during collaborative search." CHIIR, 2018

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- ✦ With forum discussions, recorded talks, videos, blogs, code repositories data scientists did:
  - ✦ Discovery, establish credibility, aided reading.

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- ✦ Knowledge context in SERPs[1]

- ✦ The knowledge context as a reading and skimming aid[2]

[1] Smith, Catherine L., and Soo Young Rieh. "Knowledge-context in search systems: Toward information-literate actions.", CHIIR, 2019

[2] Rachatasumrit, Napol, et al. "CiteRead: Integrating Localized Citation Contexts into Scientific Paper Reading." IUI, 2022

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✦ The knowledge context as a reading and skimming aid [2]

✦ Provider fairness and the knowledge context [3]

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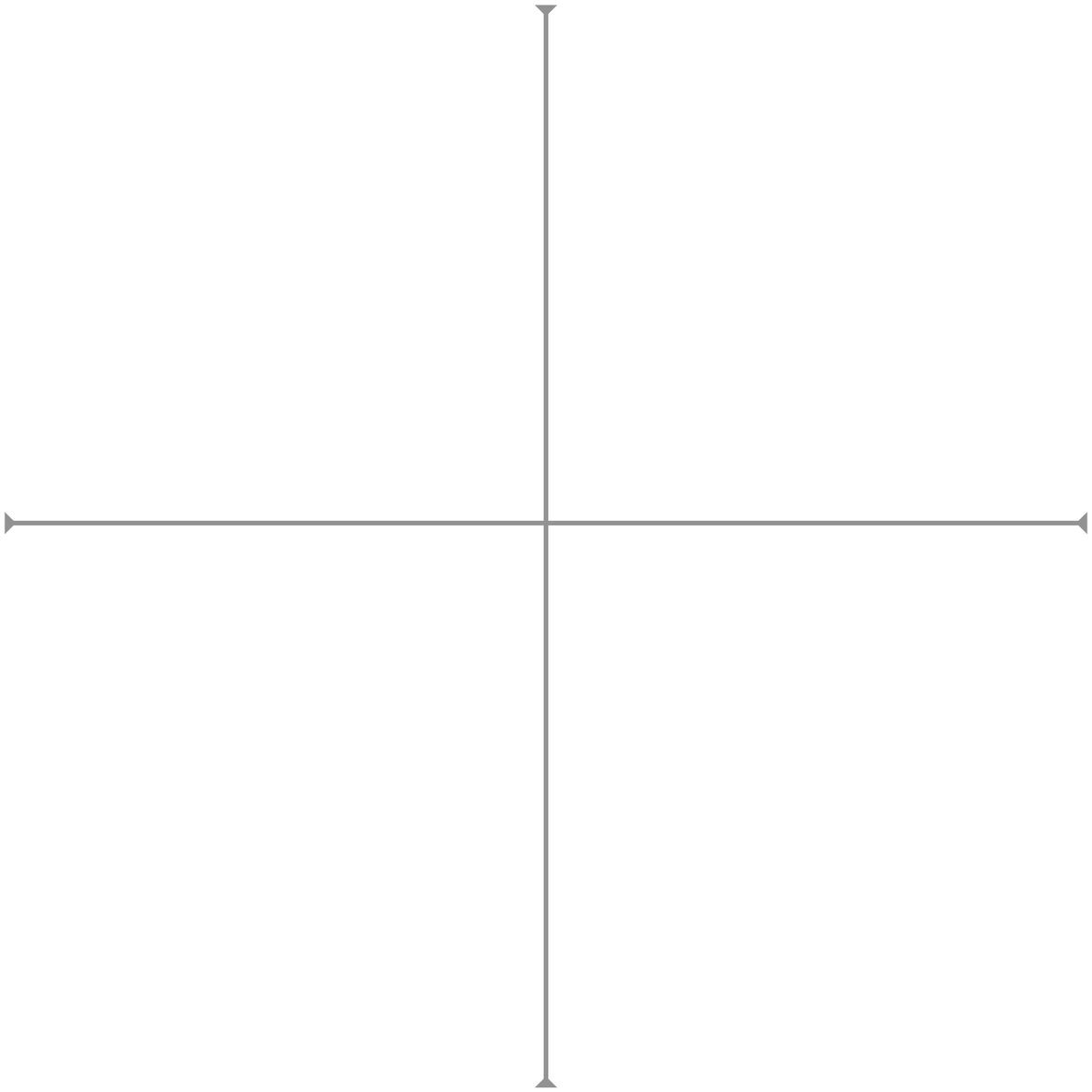
[2] Rachatasumrit, Napol, et al. "CiteRead: Integrating Localized Citation Contexts into Scientific Paper Reading." IUI, 2022

[3] McDonald, Graham, Craig Macdonald, and Iadh Ounis. "Search results diversification for effective fair ranking in academic search." IRJ, 2022

Summary



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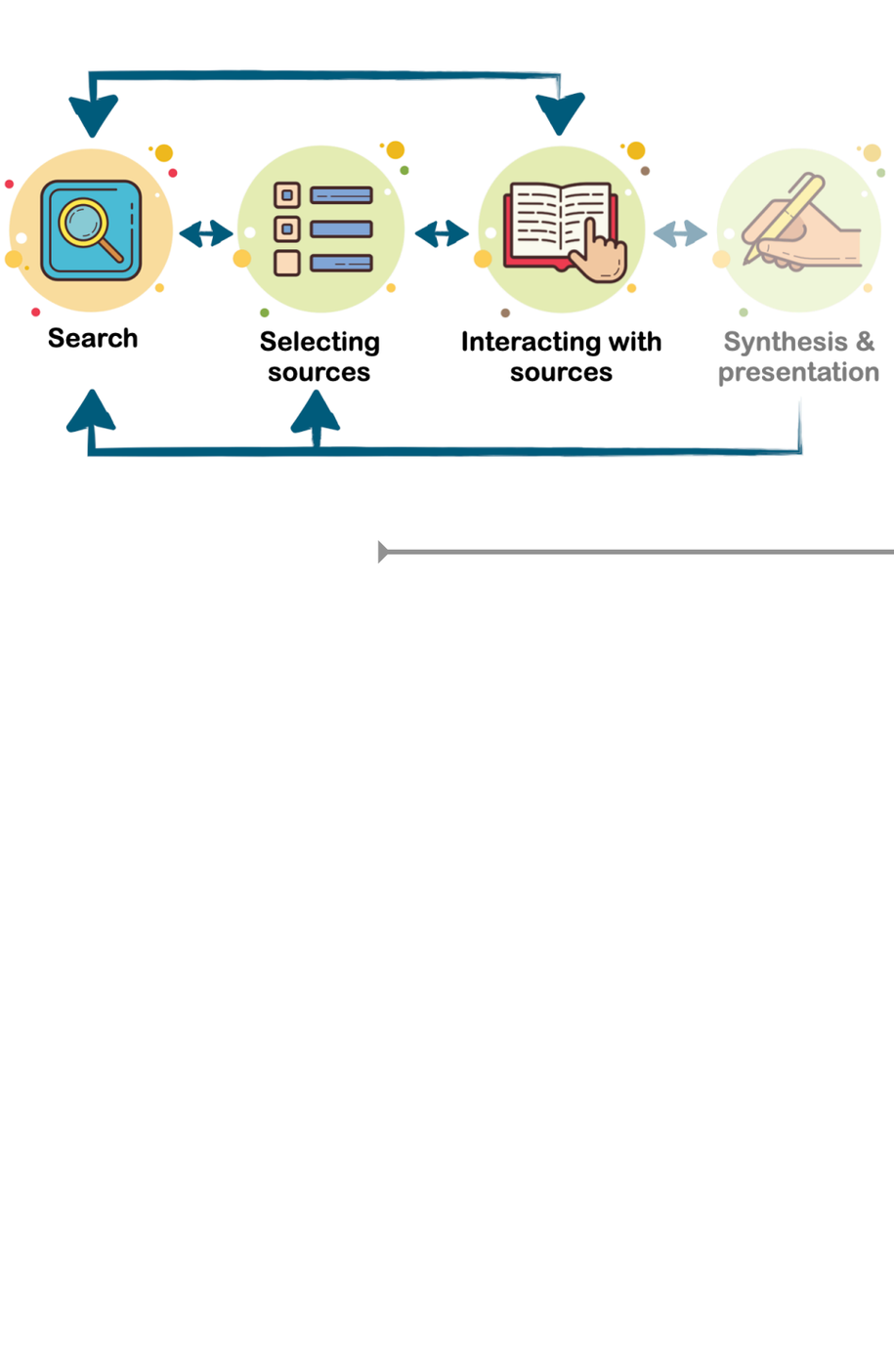
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Selecting sources
Interacting with sources
Synthesis & presentation

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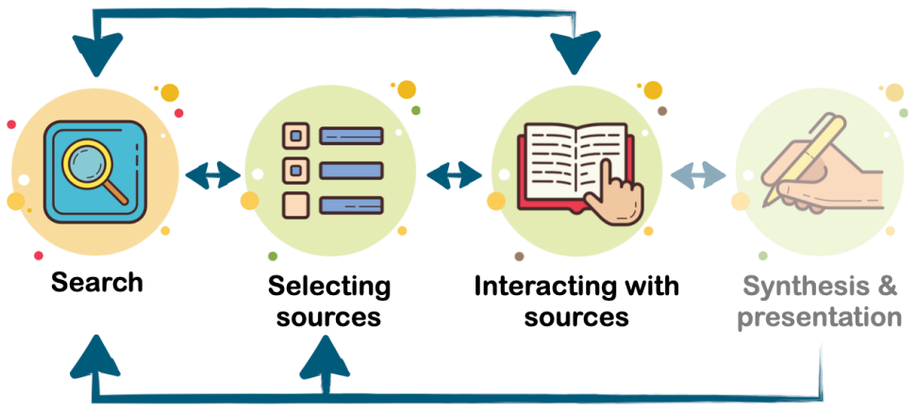
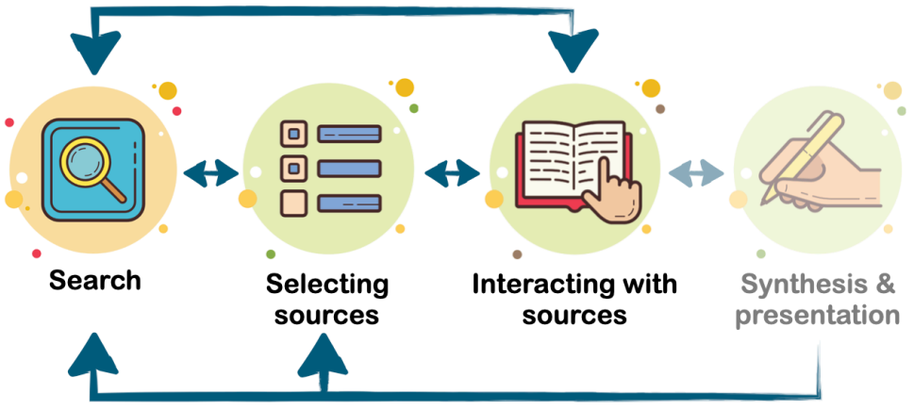


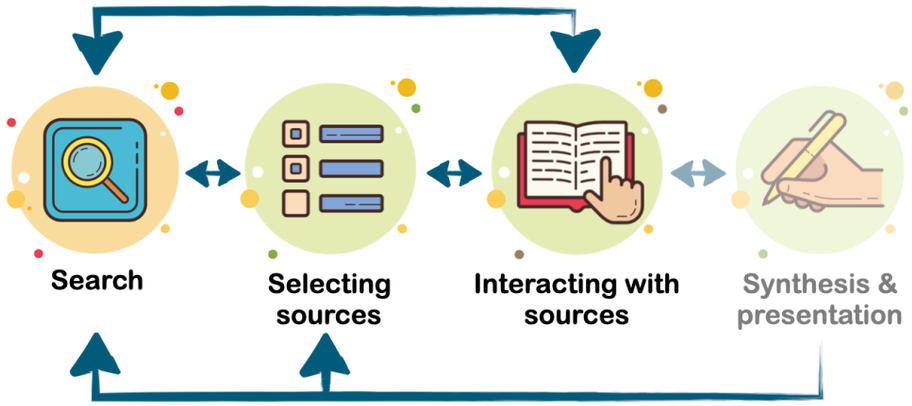
- ✦ 20 participants
- ✦ University, industry/non-profit

Summary



- 20 participants
- University, industry/non-profit

Summary



- 20 participants
- University, industry/non-profit

- Why do data scientists access the literature?
- How do they access the literature?
- How do they select papers?
- What challenges do they face in reading papers?
- How do they lean on social ties?

How Data Scientists Review the Scholarly Literature

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Code, themes, extended quotes

`MSheshera/dslitreview-study`

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