HCI Papers Cite HCI Papers, Increasingly So

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ABSTRACT

We propose X-index —the proportion of papers' citations coming from outside their research field—and use this metric to analyze citations of CHI, UIST, and CSCW papers between 2010 and 2022. We found an overall decreasing X-index by several measures, indicating that HCI papers have been more and more likely to be cited by HCI papers rather than by non-HCI papers.

CCS CONCEPTS

• **Human-centered computing**;

KEYWORDS

HCI, Citation Metrics, Discipline, Impact

1 INTRODUCTION

Human-Computer Interaction (HCI) is often considered as one of the most interdisciplinary research fields. Thus we hypothesize that HCI papers must have impact beyond HCI, which can be indicated by how often an HCI paper is cited by non-HCI papers. Unfortunately, conventional citation metrics, such as h-index or i-10-index, cannot indicate such impact because they only count the number of citations but not the sources of citations.

To address this, we propose X-index —a simple metric that measures how often a paper's citations cross the disciplinary boundaries. Given a set of venues representing a research field, the X-index of the papers in this field is defined as the proportion of citations of these papers *not* coming from these venues.

We compiled a list of core HCI venues and analyzed X-index of papers from CHI, UIST, and CSCW (hereafter referred to as **HCI papers**) published between 2010 and 2020[1]. We found that

- X-index of more recently published HCI papers have a lower X-index than earlier papers';
- If only considering HCI papers that have existed for at least five years, the more recently-published papers' X-index is still lower;

- Amongst all the HCI papers cited in a given year, the earlier papers tend to have a higher X-index than the later ones;
- In the more recent years, HCI papers seem less likely to be cited by papers outside of our core HCI venue list.

2 DATASET

2.1 Core HCI Venues

To calculate HCI's X-index , we first need to define what is considered an HCI paper so that we can know which are HCI *vs.* non-HCI citations. To the best of our knowledge, there is no existing 'catalog' of all HCI venues that publish HCI papers. Thus we refer to two sources to compile a list of core HCI venues: the SIGCHI-(co)sponsored conferences [5] and Google Scholar's top publications under the "Engineering & Computer Science - Human Computer Interaction" category [4]. In addition, we manually added a few venues we consider should be equivalent to those already in the list, *e.g.*, GI, INTERACT, ISWC, OzCHI, and NordiCHI.

Table 1 shows the compiled core HCI venues For each venue, we manually extract a subset of words from its official name to serve as a unique identifier, which we later use in keyword-matching to determine whether a citation is HCI or not.

Admittedly, what is not in this list is not necessarily "non-HCI"; it is just not included by the two sources we chose. Nonetheless, we argue that this list approximates the "boundary" between HCI and the non-HCI world. The more we see citations of an HCI paper coming outside of this list (*i.e.*, higher X-index), the more likely this HCI paper is having an impact across this "boundary". We hereafter refer to papers published outside of this list as **non-HCI papers**.

2.2 Citations of CHI, UIST, and CSCW Papers

Next, we collected DOI data of CHI, UIST and CSCW papers between 2010 to 2020[2] from the "What The HCI" [6] website maintained by Kashyap Todi. We chose CHI, UIST and CSCW because they are three of the most well-recognized HCI venues. It is certainly possible to acquire DOI data of other HCI venues (*e.g.*, TOCHI) from other sources (*e.g.*, ACM Digital Library).

Then, we port the DOI data into the Citation Chaser app [2] developed by Neal Haddaway, which uses the Lens.org API [3] to retrieve citations of a paper based on its DOI. All the citation data was in the .ris format and collected in January 2023. We did find that this API did not seem to find all the citations. Thus it is best thought of as a sampling, rather than an exhaustive retrieval, of papers' citations. We do not believe such a limitation invalidates the subsequent X-index calculation unless the missing citations were biased (*e.g.*, missing citations mostly came from HCI venues only).

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[1]Our dataset and source code can be found at https://github.com/hotnAny/x-index.

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[2]Except for CSCW 2020 papers, which the website did not provide.

ASSETS	ACM SIGACCESS Conference on Computers and Accessibility
AutomotiveUI	International Conference on Automotive User Interfaces and Interactive Vehicular Applications
AVI	International Conference on Advanced Visual Interfaces
C&C	Creativity and Cognition
CHI	ACM CHI Conference on Human Factors in Computing Systems
CHI PLAY	The Annual Symposium on Computer-Human Interaction in Play
CI	Collective Intelligence
COMPASS	ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies
CSCW	Computer Supported Cooperative Work
DIS	Designing Interactive Systems
EICS	ACM SIGCHI Symposium on Engineering Interactive Computing Systems
ETRA	Symposium on Eye Tracking Research and Applications
GI	Graphics Interface
GROUP	ACM International Conference on Supporting Group Work
HRI	ACM/IEEE International Conference on Human-Robot Interaction
ICMI	ACM International Conference on Multimodal Interaction
IDC	Interaction Design and Children
IJHCI	International Journal of Human-Computer Interaction
IJHCS	International Journal of Human-Computer Studies
IMWUT	Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies
IMX	ACM International Conference on Interactive Media Experiences
INTERACT	Human-Computer Interaction – INTERACT
ISS	Interactive Surfaces and Spaces
ISWC	International Symposium on Wearable Computers
IUI	International Conference on Intelligent User Interfaces
MobileHCI	International Conference on Mobile Human-Computer Interaction
NA	Behaviour and Information Technology
NA	International Journal of Interactive Mobile Technologies
NA	Universal Access in the Information Society
NordiCHI	Nordic Conference on Human-Computer Interaction
OzCHI	Australian Conference on Computer-Human Interaction
RecSys	ACM Conference on Recommender Systems
SMC	Transactions on Human-Machine Systems
SUI	International Conference on Spatial User Interaction
TAC	Transactions on Affective Computing
TACCESS	Transactions on Accessible Computing
TEI	International Conference on Tangible, Embedded, and Embodied Interaction
TOCHI	Transactions on Computer-Human Interaction
Ubicomp	ACM International Joint Conference on Pervasive and Ubiquitous Computing
UIST	ACM Symposium on User Interface Software and Technology
UMAP	ACM Conference on User Modeling, Adaptation and Personalization
VR	Virtual Reality and 3D User Interfaces
VRST	ACM Symposium on Virtual Reality Software and Technology

Table 1: A list of core HCI venues.

3 ANALYSES & FINDINGS

Given a set of papers' citations (total number N), we count the number (n_{HCI}) of citations that came from the core HCI venues. Then, X-index is simply $1 - n_{\text{HCI}}/N$. Specifically, for a paper that cites an HCI paper, we use simple keyword matching to determine whether that paper was published in one of the core HCI venues.
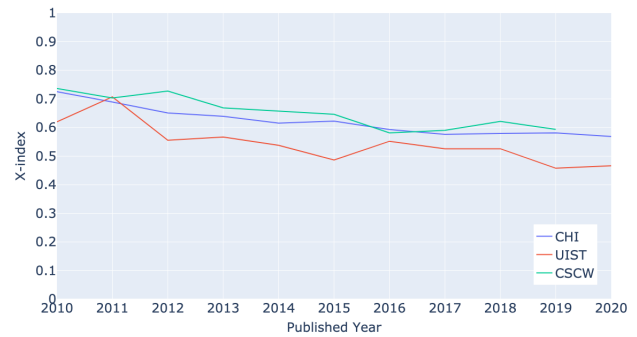

Figure 1: X-index of more recently published HCI papers (CHI, UIST, and CSCW) have a lower X-index than earlier papers'.
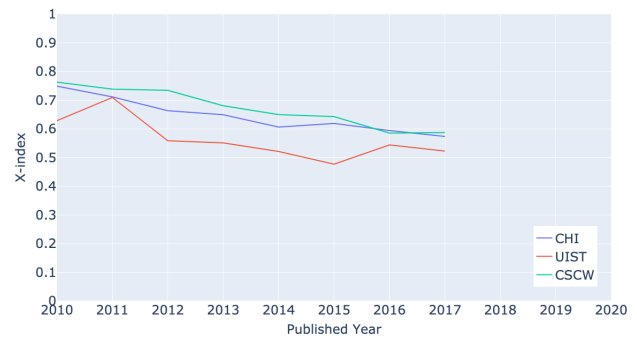

Figure 2: If only considering HCI papers that have existed for at least five years, the more recently-published papers' X-index is still lower.

3.1 X-index of HCI Papers Published Over the Years

We calculate the X-index of each year's HCI papers (*e.g.*, 11 years of UIST papers between 2010 and 2020), as shown in Figure 1. Each point in Figure 1 is the X-index value based on citations of that year's published HCI papers up to when the data was collected (January 2023). We can see that all three HCI venues' papers have an decreasing X-index over the years. In other words, HCI papers published later tend to be cited less often by papers outside of the core HCI venues.

One might question that, since citation count is also a function of time, the more recent HCI papers might be disadvantaged simply because they have not existed long enough to attract citations. To resolve this doubt, we perform the next analysis.

3.2 X-index of HCI Papers, Only Counting Citations in the Five Years After Publication

To balance the playing field, we now consider citations that occurred only within the first five years after an HCI paper was published. For example, for CHI 2015 papers, we only consider citations of

Figure 3: Amongst all the HCI papers cited in a given year, the earlier papers tend to have a higher X-index than the later ones.

them that occurred between 2016 and 2020. This constraint narrows the overall analysis down to only HCI papers published from 2010 to 2017 because, later than that, our data (collected in January 2023) has less than five years of citation information.

As shown in Figure 2, the result indicates that, even accounting for how long an HCI paper has been around, the overall X-index still seems to decrease over the years.

3.3 X-index Year-by-Year After the Publications of Each Year's HCI Papers

To further understand the relationship between X-index and how long a paper has been published, we plot each year's published HCI papers' X-index over the subsequent years, as shown in Figure 3.
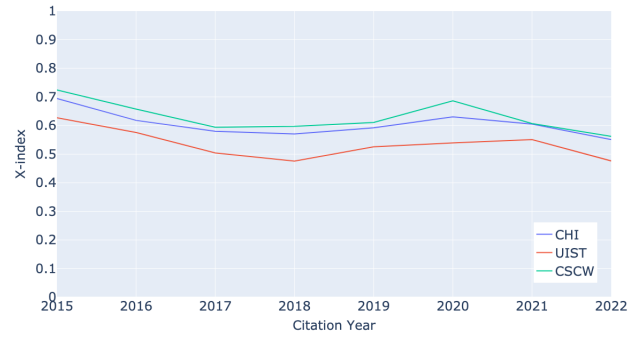

Figure 4: In the more recent years, HCI papers seem less likely to be cited by papers outside of our core HCI venue list.

Note that the *x*-axis in Figure 3 has changed: it is now citation year, not publication year. For example, when some papers in 2019 cite a CSCW 2013 paper, the citation year is 2019 whereas 2013 is the publication year. The results show that, for most years' HCI papers, their X-index tends to flatten or slightly decrease over time, except for a few 'local' cases, *e.g.*, UIST 2011's X-index kept increasing until 2014.

Amongst HCI papers cited in a given citation year, the earlier papers tend to have a higher X-index than the later ones. Consider the year 2020. For CHI, the top-3 X-index in 2020 are papers published in 2010, 2011, and 2015 whereas the bottom-3 are 2019, 2018, and 2017; For UIST, the top-3 X-index in 2020 are papers published in 2011, 2010, and 2013 whereas the bottom-3 are 2019, 2020, and 2012; For CSCW, the top-3 X-index in 2020 are papers published in 2012, 2010, and 2014 whereas the bottom-3 are 2019, 2018, and 2016.

3.4 X-index of HCI Papers Cited Over the Years

The previous analysis suggests that we can aggregate each year's citations of HCI papers so that we can see how the non-HCI papers' interest in citing HCI papers changed over the years.

For each year, we consider that year's citations of HCI papers published in previous five years. Since our HCI papers start earliest in 2010, our analysis can only begin from 2015 (A 2014 paper might cite a CHI 2009 paper but we do not have CHI 2009's citation information in our dataset).

Figure 4 shows the results, which also exhibit a decreasing pattern over the years. In other words, in the more recent years, HCI papers seem less likely to be cited by papers outside of our core HCI venue list.

4 DISCUSSIONS

4.1 Limitations of the Analyses

First, X-index intends to indicate how much non-HCI papers cite HCI papers, yet our classification of non-HCI papers is based on a list of core HCI venues. Thus some non-HCI citations might have come from HCI venues not included in our list. A common example

of this issue is various HCI workshops over the years. As a consequence, the resultant X-index in our analyses is actually inflated—the real numbers should be lower after removing the 'noisy' HCI venues from the currently-considered non-HCI citations.

Second, as mentioned earlier, we rely on Lens.org API [3] that does not seem to retrieve all citations. We do not believe such a limitation invalidates our analyses unless this API acts biasedly, *i.e.*, intentionally misses either HCI or non-HCI citations. Future work can union multiple tools and sources (*e.g.*, Google Scholar, Semantic Scholar, and Microsoft Academic) to approximate a full coverage of citations.

Third, X-index is just a number and it would be great to perform more detailed analyses, such as breaking down the citation sources of CHI. Future work can employ a more intelligent method than our simple keyword-matching approach to dissect the disciplinarity of citation sources (*e.g.*, $X\%$ HCI, $Y\%$ Computer Vision, and $Z\%$ Psychology).

4.2 Interpreting the Results

Does our X-index analyses mean that HCI has a decreasing impact across the disciplinary boundary? It seems so; at least we can say that relatively fewer and fewer papers outside of the core HCI venues are citing HCI papers.

One counter-argument against the above could be that HCI venues themselves might have become more and more interdisciplinary. Thus citations coming from within these HCI venues can also indicate impact across what used to be the disciplinary boundary.

It is also possible that the number of HCI venues is growing much faster that of non-HCI venues. In that case, even if more and more non-HCI venues are citing HCI papers, X-index will still decrease because the denominator is increasing faster than the nominator.

It will be interesting for future work to analyze X-index of other research fields. For example, according to Google Scholar, as of March 2023, CVPR has the highest h-index amongst all "Engineering & Computer Science" publications—Should we expect CVPR to have a high X-index ?

Finally, regardless of how we should interpret these analyses, as a field, HCI should develop more awareness of its impact beyond HCI (*e.g.*, a recent analysis by Cao *et al.* on industrial impact [1]), rather than remaining complacent with validating each other's work internally via having more and more HCI papers cite other HCI papers.

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