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The State of Bronze Open Access in Web of Science

The State of Bronze Open Access in Web of Science

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Bronze OA is an under-researched facet of open access (OA) surrounded by many uncertainties regarding its causes and their individual significance. This study aims to reduce these uncertainties by providing an overview over the state of Bronze OA within Web of Science, and by investigating relationships between research fields, publishers, and their rates of Bronze OA. We analyze 3,943,511 Bronze OA publications registered in Web of Science since 2000, applying statistical analyses and heat maps. Our results show high occurrences of Bronze OA in biologic and medical fields, while arts & humanities, engineering sciences, physics, and chemistry comprise the lower end of the spectrum. Regarding publishers, large university presses and the BMJ Group stand out as heavy users of Bronze OA. Continuations of this study will semi-manually investigate article pages of Bronze OA publications to provide empirical evidence for the significance of different speculated reasons for the Bronze OA label.

1. Introduction

Aim of the *Open Access* (OA) movement - itself a facet of the more general *Open Science* movement - is to make scholarly publications publicly available to read, copy, distribute, and reuse without any financial or technical bounds. Even though many of its technological and conceptual precursors already originated in the last two decades of the twentieth century, e.g., dissertation and preprint servers, an early milestone for the OA movement can be seen in the Budapest Open Access Initiative's declaration (Chan et al., 2002). Two decades later, the persistence of the momentum behind international endeavours towards OA is exemplified by recent initiatives like *Plan S,* proclaimed in 2018 by a group of national research funding organisations, international and European organisations, and charitable foundations under the name of *cOAlition S*. Its ambitious goal: to publish from January 2021 onwards any outputs resulting from research funded by its members immediately in OA venues or repositories without embargo.

Recent studies analyzing which share of research literature is already openly available typically estimate this share to lie somewhere between 20 and 60% (Hobert et al., 2021; Martín-Martín et al., 2018; Piwowar et al., 2018; Robinson-Garcia, Costas, et al., 2020; Robinson-Garcia, van Leeuwen, et al., 2020; Simard et al., 2021), with considerable variation between publication years, research fields, and geographic regions. So, although the goal of open accessibility of research publications as a default seems still far from reached, the magnitude, speed, and determination of initiatives like *Plan S* illustrate the ongoing drive behind the OA movement.

For scholars aiming to measure the uptake of OA, a particularly meaningful innovation arrived in 2018 in the form of the service *Unpaywall*. Maintained by the non-profit organization *OurResearch*, Unpaywall harvests and connects OA data from over 50,000 publishers and repositories, allowing users of its API or browser extension to identify OA statuses of research publications by DOI. By now, Unpaywall's content on OA statuses is implemented in more or less all major bibliographic databases, i.e., *Web of Science*, *Scopus*, *Dimensions*, or *OpenAlex*. Its unchallenged position as a scalable and (fairly) accurate provider of OA information led to

a far-reaching prevalence of Unpaywall data in recent scholarly analyses of OA uptake and according developments. Regardless of all benefits that Unpaywall brings to the field of science studies, such an ascendance might of course come with unwanted side-effects. First, Unpaywall is not free of selection biases - its reliance on DOIs, for instance, might undermine the OA presence within subject areas in which according identifiers are not as commonly used, e.g., in certain social sciences or humanities (Robinson-Garcia, van Leeuwen, et al., 2020). Second, the differentiation of OA classes applied by Unpaywall - namely the distinction between Green, Gold, Hybrid, and Bronze OA - only reflects one of many possible taxonomies of OA models (see for instance Archambault et al., 2014; Laakso & Björk, 2013; Piwowar et al., 2018; van Leeuwen et al., 2018), and its dominance within scholarly communication might shift the discussion away from other promising models like Diamond OA, which are not explicitly represented in Unpaywall's data.

One particular novelty introduced by Unpaywall to the bouquet of distinct OA models is the class of *Bronze OA* (Piwowar et al., 2018). Bronze OA describes articles that are free to read on publisher-hosted sites, but do not carry any license information - intentionally or not. Applying a strict definition of OA (one in full accordance with the Budapest Open Access Initiative), such articles actually would not fulfill all requirements necessary to truly be considered OA. First, their lack of an identifiable license means that Bronze OA articles do not explicitly allow reuse beyond reading; second, it is unclear how permanent their open accessibility will be (Piwowar et al., 2018).

The aftermath of the COVID-19 pandemic provides impressive examples for this second point's relevance. For instance, on August 30 2023, PubMed Central (PMC) announced on their website that, due to the expiration of the COVID-19 public health emergency and on behalf of publishers' requests, ~50,000 articles which publishers had temporarily made openly accessible would be removed from the PMC OA subset, of which ~1,500 articles would be removed from PMC entirely.[1]

This highlights another characteristic difference between Bronze OA and the other OA classes distinguished by Unpaywall: the actors deciding about it. While it is the publications' authors that decide whether an article appears as Green, Gold, or Hybrid OA, the decision about publishing an article as Bronze OA is made by the publishers (Sanford, 2022). The reasons for which publishers make use of Bronze OA are not precisely known and likely diverse; Robinson-Garcia, van Leeuwen, et al. (2020) mention health urgencies (like the COVID-19 pandemic), promotional campaigns, and embargo periods of 'Delayed OA'-models as such possible reasons. Piwowar et al. (2018) additionally state openly licensed publications that do not make their license available and "hidden gold journals" not listed in the DOAJ as potential causes for publications to be labelled Bronze OA. Thus, Bronze OA currently is a vaguely defined basket concept to unify a nontransparent plethora of heterogeneous phenomena.

This study is part of a research in progress that aims to contribute to reducing the uncertainties surrounding Bronze OA. Within this paper, we aim to provide a comprehensive overview over the current state of Bronze OA in the prominent bibliographic database *Web of Science*, particularly focussing on potential relationships between prevalence of Bronze OA and research fields as well as scholarly publishers. Continuations of this study will aim to provide empirical insights into the significance of the different causes for Bronze OA (e.g., publishers' promotional campaigns, delayed OA, hidden gold journals, incomplete license information)

[1] https://pmc.ncbi.nlm.nih.gov/about/new-in-pmc/#2023-08-30 (Retrieved on March 26, 2025)

and investigate how publishers' or journals' explicit strategies affect the occurrence of Bronze OA.

2. Methods and Data

In the following section, we first provide a general overview over distributions of different open access statuses in this study's analysis dataset, before explaining the more advanced methods used for its analysis in greater detail.

2.1 Dataset overview

The analyses within this study are based on a snapshot of Web of Science reflecting the database's state in July 2024 provided via the data infrastructure of the German Competence Network for Bibliometrics (Schmidt et al., 2024). As our baseline, reflecting the entirety of Web of Science from publication year 2000 onwards, metadata for all 54,617,576 records within said snapshot and timeframe were downloaded. This metadata includes information on publications' open access (OA) availability that is provided by Unpaywall and was used in this study to distinguish between Green OA, Gold OA, Hybrid OA, and Bronze OA. Publications without any known OA version were considered to be available "closed only". Figure 1 on its left shows the frequencies of these access types across the publications of our analysis dataset (n = 54,617,576). As Green OA can for each publication occur in combination with either Gold, Hybrid, or Bronze OA, the right side of Figure 1 shows the Venn diagram of such overlaps within the publications analysed here.

Figure 1: frequencies of OA types within the dataset (left) and OA types' overlaps (right).

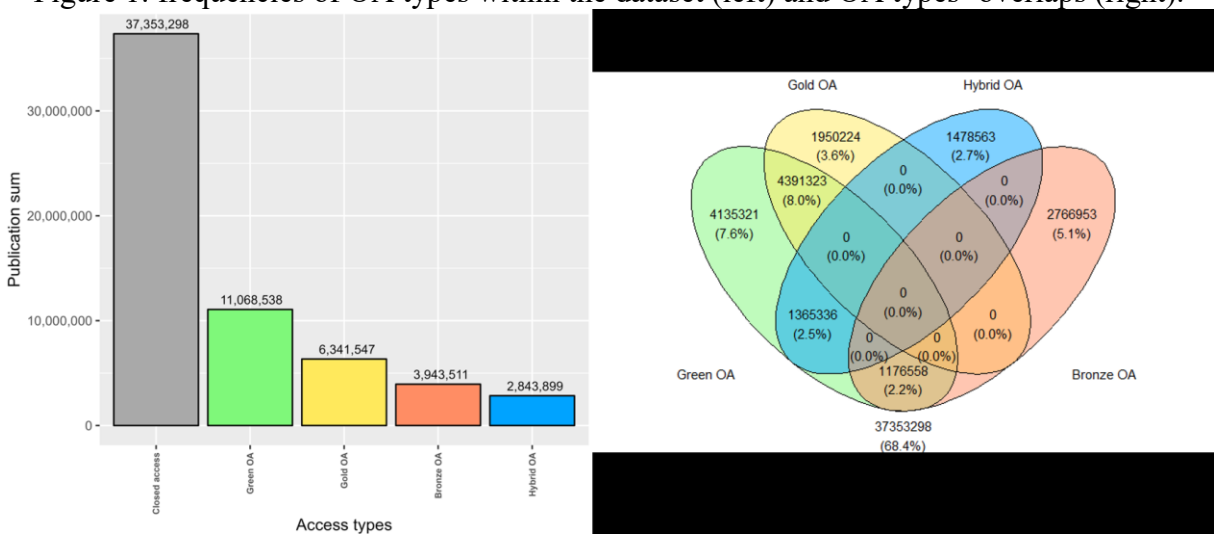
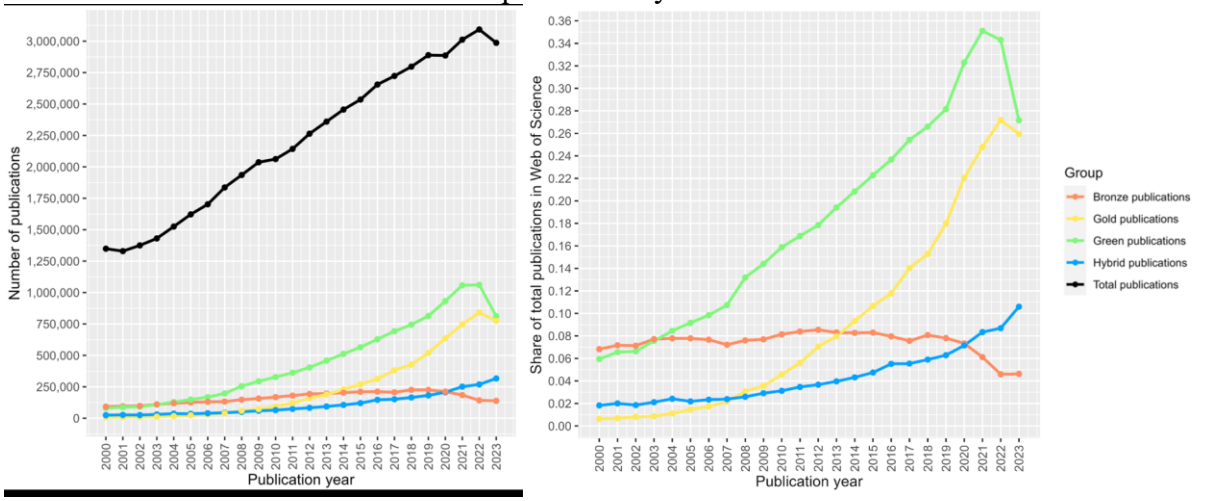


Figure 2 shows the prevalence of OA publications over the years since 2000, both in total (left side) and relative to the annual amount of new publications (right side).

Concerning the share of Bronze OA among total publications, it up to 2020 consistently remains between 7 and 9%. Afterwards, both the total and the relative amount of Bronze OA publications declines. We cannot say at this point whether there is a systemic explanation behind this trend - which could for instance be the effects of transformative agreements like Projekt DEAL (see also Fraser et al., 2023), or deliberate tendencies among publishers to make fewer of their most recent articles available under Bronze OA, or a general decline of the Bronze OA publication model - or whether it is simply caused by time lags in Unpaywall's correct identification of recent publications' Open Access statuses. For Green and Gold OA similar declines in the most recent years are visible, although these do not go as far back. Specifically

regarding Green OA, the lower amount of Green versions in the most recent years can probably at least partly be explained by the "backfilling effect" (Archambault et al., 2014), i.e., many authors' tendency to over time upload Green OA versions of their older publications, even years after their original publication.

Figure 2: absolute shares of access types (left) and relative shares of OA types (right) per publication year.



2.2 Mapping of disciplines

To calculate shares of disciplines among publications, we first map Web of Science subject categories (WC) to Essential Science Indicators fields (ESI), because the latter's distinction of 23 fields results in a granularity more suitable for our in disciplinary terms fairly broad analysis than the 254 Web of Science subject categories. To do so, we use the mapping suggested by Arroyo-Machado & Torres-Salinas (2021) and for each publication map every WC subject category to one ESI field accordingly. If a publication is tagged with multiple WC categories that correspond to the same ESI field, it receives the respective ESI tag only once. E.g., a publication with the Web of Science categories *Biology, Microscopy, Biophysics* (all of which map to *Biology & Biochemistry* in the ESI taxonomy), and *Crystallography* (which in the ESI taxonomy maps to *Chemistry*) would after the mapping be counted once as a publication of discipline *Biology & Biochemistry* and once as a publication of discipline *Chemistry*.

2.3 Aggregation of publishers

In order to analyse different large publishers' inclination towards offering their content as Bronze OA, we aggregated their various alternative spellings and imprints present in the Web of Science database into the larger publishing corporations they represent (in total, the Web of Science snapshot used in this study differentiates between 10,151 different publishers). As a first, broad measure of aggregation, searches for distinct publisher names were conducted to quickly unify the oftentimes many different spellings of the same publishing house – e.g., the various forms of Elsevier, like *Elsevier Inc*, *Elsevier Sci Ltd*, or *Elsevier GmbH*, were all unified under the name *Elsevier* by a string search for 'Elsevier' across publisher names. To which larger publishing house other individual publisher names belong to was largely determined via manual web search – the respective information was most often found on the individual publisher's homepage or Wikipedia.

Starting from the most prevalent publisher names in Web of Science downwards, this procedure of publisher reclassification was iteratively continued until at least the 25 most common publishers in our dataset consisted entirely of self-defined aggregations (like 'Elsevier' in the

example above). In addition to these 25 large publishing houses, we added a basket category named *Prof. Society/Institute* to unify various smaller university presses, research associations or academic societies into one category. The remaining individual publishers were grouped under the label *Others*.

The R script resulting of this entire process is freely available for reuse on Zenodo.

3. Results and Discussion

In the following section, we will first inspect the distribution of the 3,943,511 publications from our dataset that are available as Bronze OA across the 23 ESI fields, then look at the shares of individual publishers' publications that are available as Bronze OA, and finally look at the rates of Bronze OA among intersections of individual publishers and ESI fields.

3.1 Bronze OA across disciplines

Figure 3 answers the question: how large are the shares of publications available as Bronze OA across disciplines? We see stark differences between the disciplines regarding their availability as Bronze OA: for *Space Sciences* this share is almost 30%, while *Arts & Humanities* constitute the other end of the spectrum, with only 1.9% of respective publications being available as Bronze OA. Overall, we see the publications from various fields related or directly adjacent to Biology and Medicine to be particularly commonly available as Bronze OA - for *Immunology*, *Molecular Biology & Genetics*, *Clinical Medicine*, and *Plant & Animal Science* the Bronze OA shares all lie between 10 and 17%. Besides humanities, the lower end of the spectrum comprises various forms of social sciences, engineering sciences and the remaining natural sciences.

Figure 3: shares of disciplines' publications that are available as Bronze OA (since 2000).

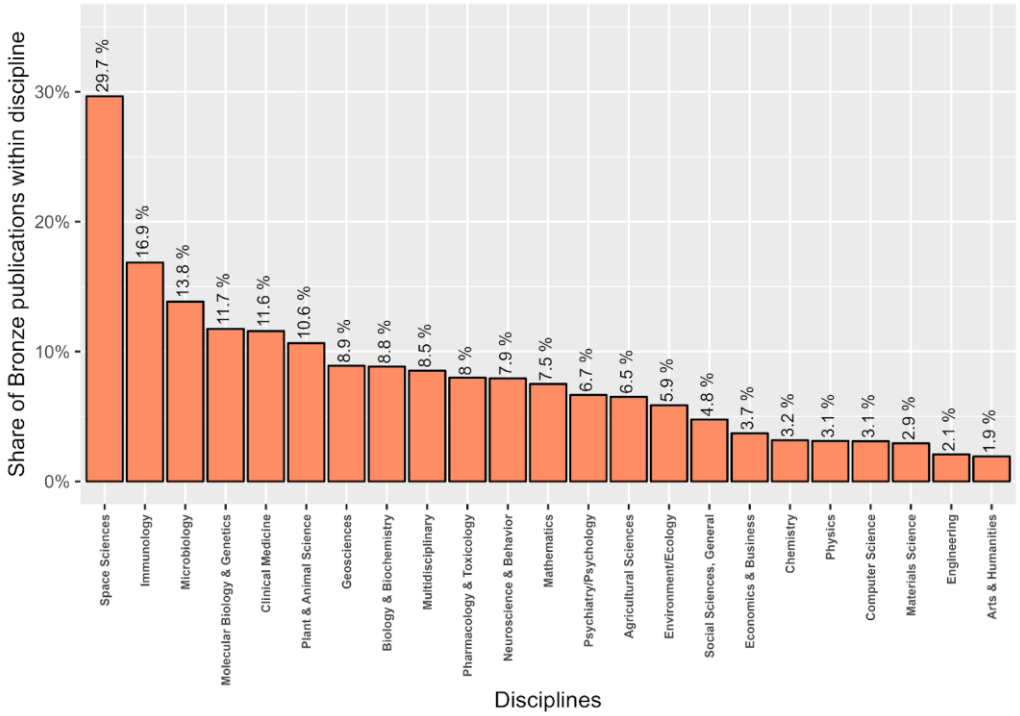
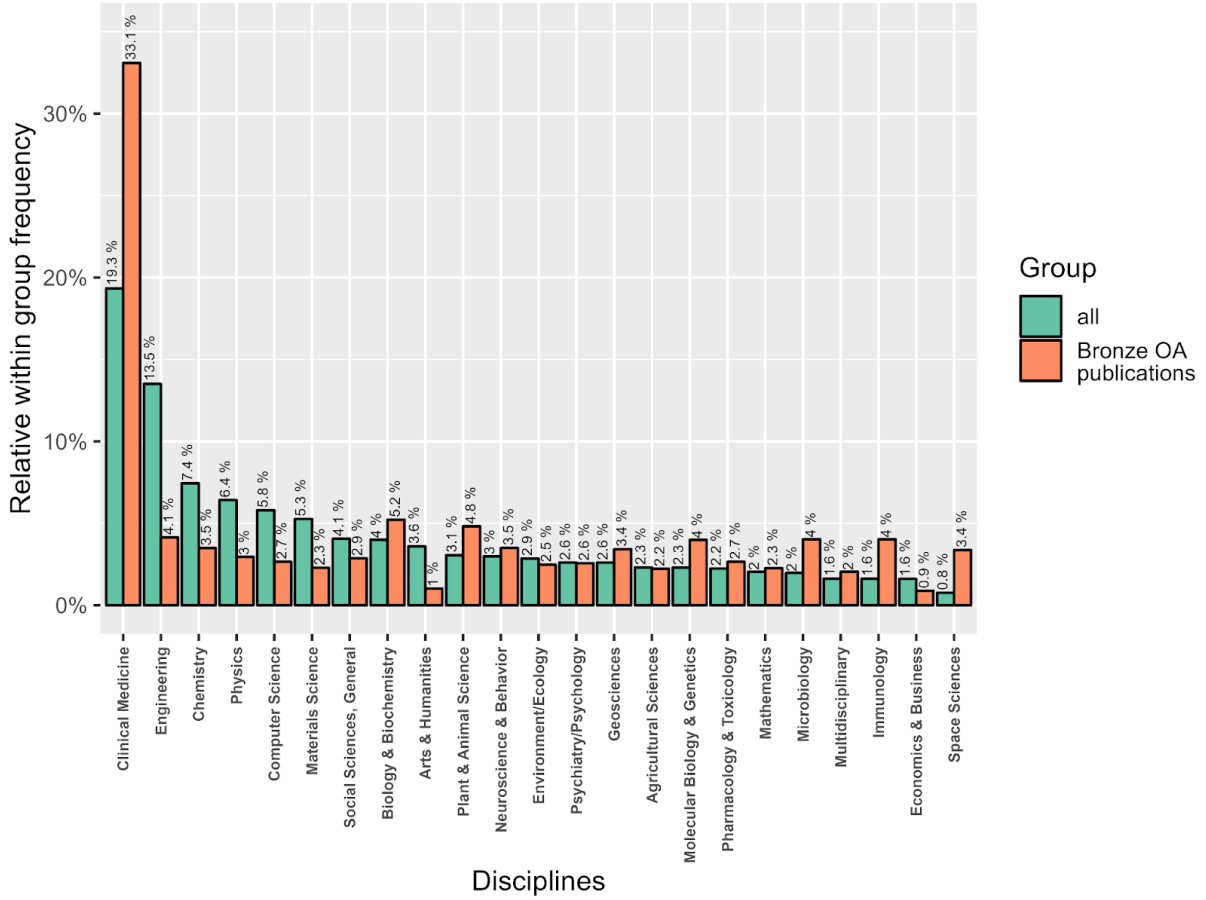


Figure 4 answers the reverse question to Figure 3: which disciplines make up how much of the entirety of all Bronze OA publications within Web of Science (from publication year 2000 onwards)? And, for comparison: how large are those disciplines' shares among all Web of Science publications within that time frame, regardless of access type?

This view helps to illustrate the substantial share of *Clinical Medicine* (33.1%) among the corpus of Bronze OA literature, due to both the discipline's large share among Web of Science publications in general and its quite strong individual share of Bronze OA, the latter of which could already be seen in Figure 3. We also see how certain fields like *Engineering*, *Chemistry*, *Physics*, *Computer Science*, *Materials Science*, and *Arts & Humanities* seem to be underrepresented among the set of Bronze OA publications, compared to their comparatively large shares among the entirety of recent Web of Science publications.

Figure 4: shares of disciplines among the entirety of Web of Science (with publication year >=2000) and its Bronze OA publications.



3.2 Bronze OA across publishers

In Table 1 below, we investigate the shares of Bronze OA among publishers' Web of Science publications since 2000, applying our self-developed aggregation of publisher names (see also subsection 2.3). The column *Disciplinary focus* contains ESI fields that at least 20% of said publisher's publications belong to (according to the discipline mapping described in subsection 2.2).

The results seen in Table 1 reveal substantial differences in individual publishing houses' inclination towards making their content available as Bronze OA, with many of them either clearly surpassing or falling below the overall 7.2% share of Bronze OA among our dataset (see also Figure 1). The bottom of the list is – to little surprise – comprised of the five designated OA publishers of our set (*Frontiers, BioMed Central, PLOS*, *MDPI* and *eLife*). These publishers Bronze OA does not concern per definition due to their publications being Gold OA by default

(why some of them still include some publications that Unpaywall recognizes as Bronze OA remains to be investigated). The top of the table shows two university presses and the *BMJ Group*. Overall, the table in part appears to echo the relationship between Bronze OA and disciplines that we have seen in subsection 3.1, with (non-open access) publishers with a clear focus on biomedicine being at the top, and publishers with a focus on natural sciences or engineering appearing towards the bottom.

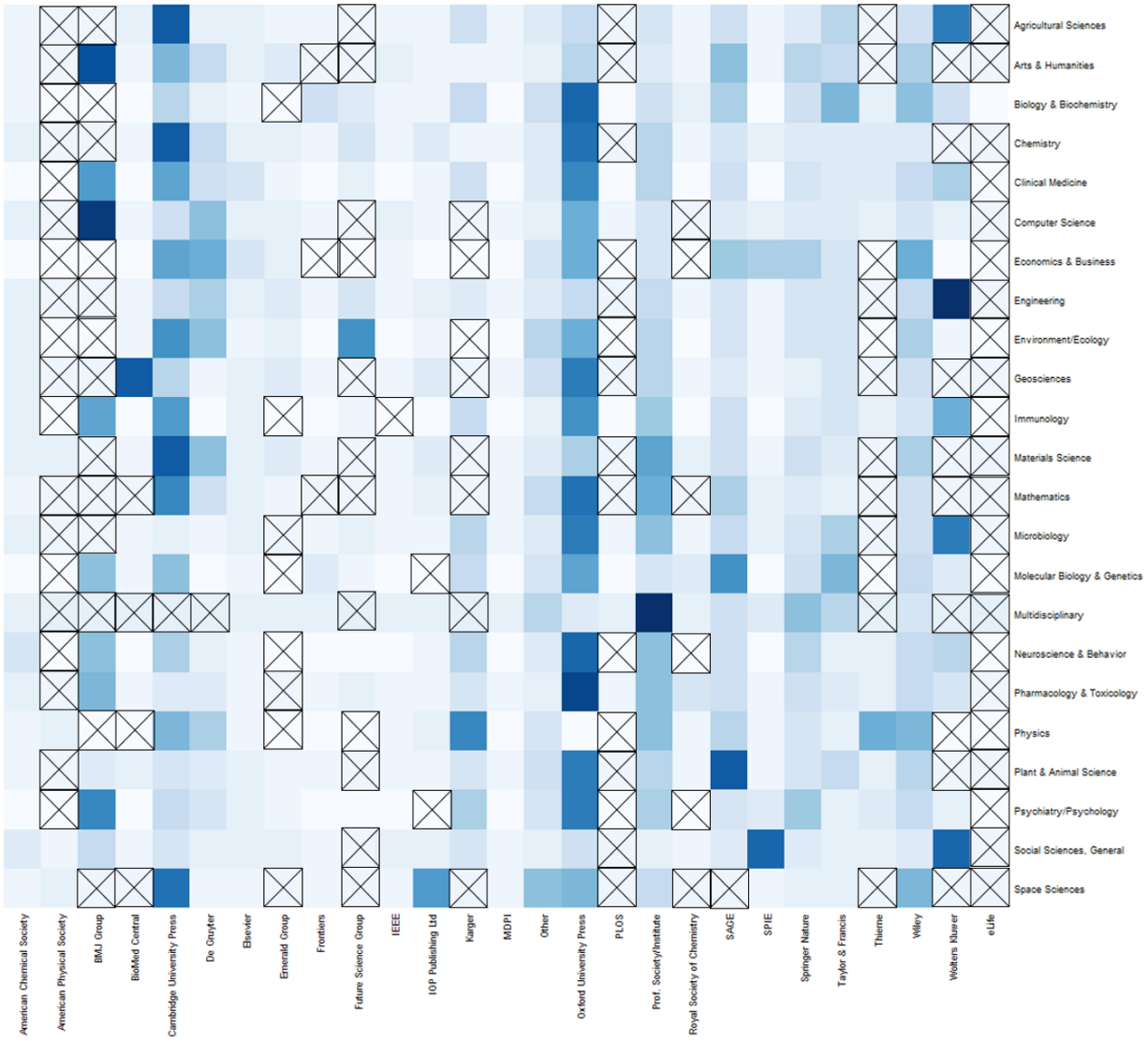
Table 1. Shares of Bronze OA among publishers' Web of Science publications (since 2000).

Publisher	**Number of publications**	**Bronze OA share**	**Disciplinary focus**
Oxford University Press	1,409,998	29.1%	Clinical Medicine
BMJ Group	321,042	27.3%	Clinical Medicine
Cambridge University Press	490,779	16.0%	Clinical Medicine
Wolters Kluwer	1,515,346	15.4%	-
Karger	216,381	12.0%	Clinical Medicine
Prof. Societies/Institutes	9,326,174	11.8%	-
IOP Publishing Ltd.	549,194	10.8%	Physics
Wiley	4,869,522	10.7%	Clinical Medicine
SAGE	993,372	7.7%	Clinical Medicine, Social Sciences
Springer Nature	5,654,946	6.9%	-
De Gruyter	171,163	6.8%	-
Thieme	207,324	6.7%	Clinical Medicine
Taylor & Francis	1,878,778	5.5%	-
Other	7,356,076	5.4%	-
Future Science Group	34,883	4.2%	-
Elsevier	10,706,143	3.5%	Clinical Medicine
American Physical Society	425,416	1.7%	Materials Science, Physics
Emerald Group	119,150	1.7%	Economics & Business, Engineering
American Chemical Society	1,415,038	1.0%	Chemistry
SPIE	335,735	0.9%	Engineering, Physics
Royal Society of Chemistry	554,321	0.7%	Chemistry
IEEE	3,506,938	0.7%	Computer Science, Engineering
Frontiers	487,613	0.6%	-
BioMed Central	447,374	0.6%	Clinical Medicine
MDPI	1,257,110	<0.1%	-
PLOS	351,605	0%	Multidisciplinary
eLife	16,155	0%	Biology & Biochemistry

3.3 Bronze OA across intersections of publishers and disciplines

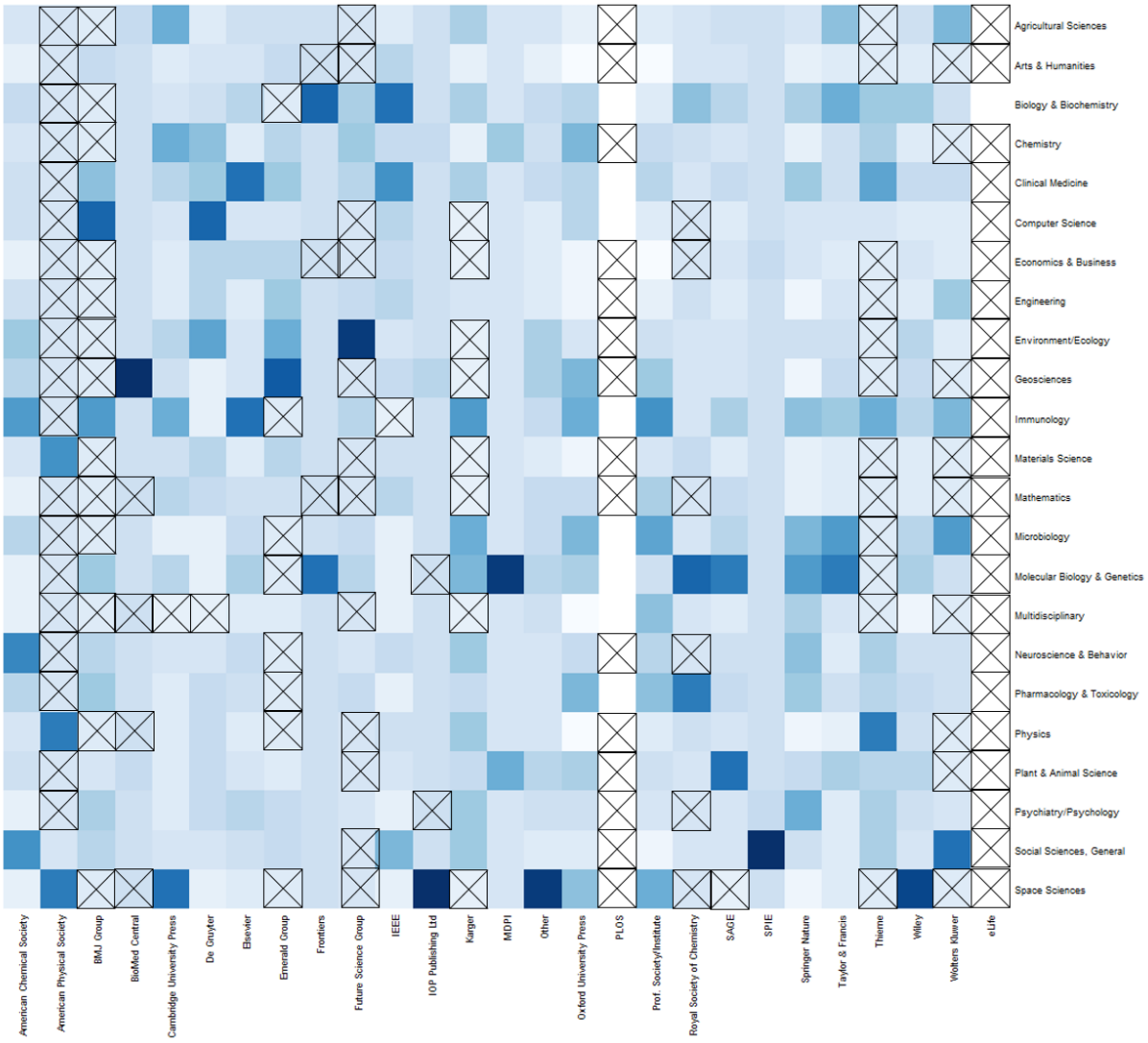
The heat map shown in Figure 5 reflects the shares of individual publishers' portfolios from a certain discipline that are available as Bronze OA. The darker the cell, the higher the share of said publisher's publications from the respective discipline that are available as Bronze OA. Crossed out cells mean that the respective publisher is not active in the respective field. The heat map shown in Figure 6 follows the same logic, but each cell is normalized by publisher, to potentially make discipline-specific effects that are publisher-independent visible (which would then appear as consistently dark rows in the heat map).

Figure 5: heat map of publishers' shares from disciplines that are available as Bronze OA (since 2000).



In Figure 5, the overall dark columns of *BMJ Group*, *Cambridge University Press*, or *Oxford University Press* reflect those publishers' generally high shares of Bronze OA, which we have already seen in Table 1. However, between columns there seem to be little commonalities. While *Oxford University Press* for instance shows particularly high Bronze shares in *Pharmacology & Toxicology*, *Neuroscience & Behavior*, or *Biology & Biochemistry*, the same is not true for the other two publishers regarded in this example. Vice versa, in the portfolio of *Cambridge University Press*, Bronze OA seems particularly common in fields like *Space Science*, *Materials Science*, *Chemistry*, or *Agricultural Sciences*, although the same does not apply to most other publishers' portfolios. This suggests that there do not seem to be strong disciplinary cultures with regard to the use of Bronze OA that affect different publishers in the same (or similar) ways. Figure 6, in which cell values have been normalized by publisher, seems to confirm this comparatively minor role of disciplinary cultures in this regard, as no distinct rows of publisher-independently high relative intensity seem visible.

Figure 6: heat map of publishers' shares from disciplines that are available as Bronze OA (since 2000), normalized by publisher.



4. Conclusions

We set out to provide an overview over the prevalence of Bronze OA among publications registered in Web of Science since publication year 2000, with particular focuses on the shares of Bronze OA among scientific fields and publishers. Regarding fields, those adjacent to biosciences and/or medicine stood out as being heavily affected by the phenomenon Bronze OA, while arts & humanities, engineering sciences and natural sciences (apart from biology) comprised the lower end of the spectrum. Analyzing publishers, we also saw drastic differences regarding their individual shares of publications that are available as Bronze OA, with large university presses and publishers with a focus on clinical medicine leading the field. Inspecting scientific fields and publishers at the same time in heat maps, however, led to apparently mostly random patterns – the fields in which individual publishers tend to rely most strongly on Bronze OA seem to vary heavily between the large publishing houses.

These findings suggest that, although certain research fields have much higher shares of Bronze OA than others, these high occurrences of Bronze OA have causes that can only be explained on a lower level of abstraction than applied in this study, where we differentiated between 23 general research fields and 25 large publishers (plus two basket categories). Continuations of

this study will investigate the same questions on lower levels of abstraction (i.e., more specific research fields and smaller units within the large publishing houses), to see whether such a change of perspective leads to the discovery of patterns that more distinctly help to draw conclusions towards the main reasons for the existence of Bronze OA. In further expansions of this study, we will semi-manually investigate article pages and detailed Unpaywall API responses for Bronze OA publications to provide empirical evidence for the significance of different speculated reasons for publications to be labelled Bronze (see Jahn et al. (2022) for an example of a similar type of study focused on hybrid OA within Elsevier journals).

An inherent limitation of this research results from its focus on only one bibliographic database, Web of Science, which was chosen as a starting point due to its popularity for bibliometric analyses. As the coverage of bibliographic databases – in particular in regard to OA publications (Simard et al., 2024) – varies drastically, repeating these analyses on different sources like Scopus, Dimensions, or OpenAlex would be a further valuable follow-up to this study. Furthermore, it should be noted that – unlike many bibliometric analyses – we in this study did not restrict the set of considered publications based on their document type (e.g., to journal articles). While this was done to provide a truly comprehensive overview over the state of Bronze OA on Web of Science, it might constrain the comparability of this study's results to those of many other bibliometric studies that only consider journal articles.

This study's findings contribute to a better understanding of Bronze OA, a previously under-researched facet of OA publishing (Piwowar et al., 2018), which currently poses an element of uncertainty in many analyses of OA. They provide insights relevant for the advance- and refinement of tools designed for precisely measuring OA uptake. Thus, this research's results contribute to the development of more accurate concepts for informing about the state and progress of the OA movement.

Open science practices
All programming scripts used for data retrieval and analysis are openly available on Zenodo: https://doi.org/10.5281/zenodo.15753404.

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Author contributions
SL conceptualized this study, performed the data analysis, and provided this manuscript's first draft, including visualizations. IP was responsible for the acquisition of funding and project administration. Both authors contributed to review and editing of this manuscript.

Competing interests
The authors have no competing interests to declare.

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