Multi-metric academic profiling with ProAc

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Undertone.design
2023

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As academics, we work in an environment in which we are constantly ranked against each other leading to an unnecessarily competitive work environment. We compete for jobs, presentation slots, and scientific output. The resulting research pressure minders research quality by leaving less room for critical aspects like literature research, testing results, and mastering scientific methodologies. At the heart of the current academic ranking is the single-number metric, the h-index. The metric even fails to accurately provide the ranking itself. Here, I introduce a radically different approach: Profiling, instead of ranking, academics. A multi-metric academic profile facilitates assembling effective research teams, and reduces academic bias and unnecessary competition. The key is one single, incentive-creating visual profile, ProAc, which can be created by both individual academics and research hosts. It combines multiple new and existing metrics. As part of a more conventional qualitative CV, ProAc fosters a fairer and more efficient academic evaluation that takes advantage of objective metrics without misinterpreting them.

1 Introduction

Today, an academic career strongly depends on the peer-reviewed publication productivity and its impact. Both are meant to be reflected in one single number: the h-index (Hirsch, 2005). This number supposedly ranks all privileged and non-privileged scientists with career-breaks and without, in both their early and late

stages, from normal to outstanding, in worse and better. The number in itself is debatable (e.g., Hirsch, 2020; Yong et al., 2014), especially from an interdisciplinary perspective, as the number of citations significantly differ between individual disciplines without being a result of scientific greatness, but rather of the variation in the overall number of studies being published within the different disciplines (Anauati, Galiani, and Gálvez, 2016; Bornmann and Daniel, 2008). Yet, it is this one-dimensional ranking system that – despite great announcements – usually appears to be the sharp blade between being funded and rejected. As a result, it sows unnecessary competition between peers, unhealthy publishing pressure, and thereby increases the number of publications and decreases their quality: One high-quality study is graded less than two of them in low-quality. Moreover, past achievement is presently the key to jobs and funding (e.g., Hirsch, 2020): a huge setback for both young motivated academics and novel ideas. An employer does not necessarily want the most productive person to work in their project, they want the best-suited one for the project. A funding agency does not necessarily want to fund the most-productive person, they want to fund the person that is best-suited for making the proposed project a success. Science is not a competition between scientists, it is teamwork towards a common goal.

ProAc introduces therefore an incentive-creating profiling of academics that is based on not one, but multiple, insightful indices that allow to characterise, rather than just rank, academics objectively. The ProAc profile has been developed using both existing and novel academic indices (e.g., with the h-index included as part of it) and made accessible via an effective graphical representation. To circumvent the initial difficulty to gain access to individual academic data, but also to increase evaluation transparency, the ProAc open-access toolbox will allow all academics to create their own profile.

A broad use of the ProAc profile will likely have a significant impact on academia as a whole, as is outlined in the following three hypotheses.

- **Hypothesis 1: Academic profiling will enhance research quality instead of quantity.** Removing the omnipresent pressure to increase the h-index as swiftly as possible will enhance the quality of individual studies (e.g., by allowing for more creative approaches) and reduce the quantity of low-quality studies.
- **Hypothesis 2: Academic profiling will allow to build more effective and diverse research teams.** Individual academics should, in the optimal case, complement each other in their skill set to build an effective team for a given project. A team built on the academic profiles of its individual members, rather than on the basis of the h-index only (e.g., Batista, Campiteli, and Kinouchi, 2006), is more likely to achieve this goal.
- **Hypothesis 3: Academic profiling will reduce the psychological pressure on academics.** Removing the one-

dimensional grading of academics against each other will significantly reduce the mental stress and, with it, misbehaviour of individuals in academia (e.g., Gálvez, 2017; Van Noorden, 2020).

2 Shortcomings of academic ranking

Ranking academics against each other only makes sense on first sight. The current academic ranking system produced an unnecessarily competitive work environment in which careful research (e.g., based on scientifically thorough methodology) is an unpopular drag to the overly busy academics (e.g., Forrester, 2023). Importantly though, producing good science is generally the outcome of repeated failure; failure that we need to acknowledge and not hide, and leave plenty of room for. Instead, to compete for jobs, we substitute research quality with quantity to boost our ranking score, which depends mainly on scientific output (i.e., the number of peer-reviewed publications). This publishing pressure (a.k.a. "publish or perish") leaves little to no room, neither for daringly novel research attempts, nor for critical aspects like literature research, testing results, and mastering scientific methodologies. The results are a strong decline in disruptive science (Park, Leahey, and Funk, 2023) and, even more concerning, the rise of unnecessary community-wide methodologic flaws like the *Reproducibility crisis* (Schooler, 2014; Baker, 2016) or the *Visualisation crisis* (e.g., Hawkins, 2015; Crameri, Shephard, and Heron, 2020).

2.1 The h-index

At the heart of the harmful current academic ranking system is a single-number metric, the h-index (Hirsch index; Hirsch, 2005); and this metric even fails to accurately provide the ranking itself (e.g., Hirsch, 2020). The h-index is a so-called author-level metric. It attempts to represent two things: one is the academic productivity, the other is the citation impact of the publications produced (Glänzel, 2006). The h-index is applied throughout academia also for research groups (e.g., Raan, 2006), facilities (e.g., Kinney, 2007), and countries (e.g., Csajbók et al., 2007), and considered in job offering, proposal funding, and even medal awarding to the degree that an academic career might be impossible without achieving a 'high' h-index (e.g., Hirsch, 2020).

The h-index, while certainly useful in some respects (e.g., measuring the quantity of scientist's publications), is currently facing fundamental criticism, in parts by its inventor himself (Hirsch, 2020), even for the two sole purposes (i.e., measuring productivity and impact) it aims to fulfil. Some shortcomings are listed below.

- The typical number of citations in different fields is not considered, even though the citation behaviour between fields and sub-disciplines vary significantly (Anauati, Galiani, and Gálvez, 2016; Bornmann and Daniel, 2008).

- The author contribution to one publication is ignored, even though it can vary significantly between a single-authored contribution and a minimal contribution to a peers work (Sekercioglu, 2008).
- The discriminatory power is reduced due to the index being a natural number only, which does not interpolate between h and $h + 1$ (Ruane and Tol, 2008); a circumstance that is particularly problematic for early-career researchers.
- Self-citations are not excluded, which therefore leaves the h-index vulnerable to manipulation (Bartneck and Kokkelmans, 2011; Ferrara and Romero, 2013; Gálvez, 2017), and introduces a heavy bias against women (King et al., 2017).
- Coercive citations (i.e., self-interest citation suggestions of editors, but also reviewers) are not prevented but attracted (Van Noorden, 2020; Wilhite and Fong, 2012).
- The significance of the impact measure compared to simpler measures, like the total number of citations, is questionable (Yong et al., 2014).

2.2 Current h-index alternatives

For these critical reasons and others, a multitude of adjustments to the h-index (e.g., $h(2)$, hg, h_l, $h_{firstauthor}$, h_m, h_{mol}, h_{ms}, h_s, hw, *Contemporaryh*, *Rawh*, *Taperedh*, *Weightedh*) and also alternative metrics (e.g., A, AR, f, g, IQp, *Maxprod*, m, Pi, q^2, R, *Specificimpact*, t, *Wohlin*, *Wu*) have been proposed and partly applied throughout the research community (e.g., Anderson, Hankin, and Killworth, 2008; Batista, Campiteli, and Kinouchi, 2006; Bornmann et al., 2011; Sidiropoulos, Katsaros, and Manolopoulos, 2007). One widely known example is the i10 index (Connor, 2011) providing a measure for the number of publications of an academic that reached ten or more citations. Most of the many proposals (i.e., at least 37 alternatives) have been shown to be highly correlated with the original h-index and are therefore largely redundant (Bornmann et al., 2011, and references therein). Moreover, all suggested alternatives above are single-number metrics. Indeed, until today, all these alternative suggestions are built on the assumption that they need to enable a one-dimensional ranking system, for which assigning individuals to a single number is the easiest way of achieving it. However, there is no need for just providing one single measure only to grade academics against each other. In fact, a one-dimensional grading system might even be a disadvantage (see Section 2). Rather than grading them based on one single quantity, ProAc therefore proposes the novel approach to profile academics based on their various important skills and achievements.

3 Advantages of academic profiling

Instead of the one-dimensional ranking, a multi-metric profiling of academics will encourage collaboration instead of competition, boost quality-science instead of quantity-science, and promote novel ideas by early-career researchers through more effective distribution of research funds. Academic evaluation based on an academic profile allows research to build up on everyone's strength and encourages individual academics to improve their academic weaknesses. A multi-metric profile reflects the skills and achievements of academics fairer, more thoroughly, and in a less competitive manner than the presently applied h-index. This fosters more creative and higher-quality research, while decreasing the unhealthy mental pressure on academics.

The potential for such immense gains for the whole of academia is the driving force behind the ProAc initiative. ProAc is already sparking discussions and maybe, even already, some changes towards a more sensible evaluation of academics.

4 The visual academic profile ProAc

The graphic design of ProAc (Figure 1) aims to effectively represent an academic's skills, efforts, and achievements in a universally-accessible, directly-comparable, and objective manner.

4.1 Metrics of ProAc

ProAc metrics include some of the most common skills, achievements, and contributions that are typically considered in academic evaluations. The metrics should, in particular, act as incentives to create or maintain an effective academic environment in which high-quality, collaborative, diverse, open, and accessible research is central. Importantly, non of the current ProAc metrics is negatively impacted by career breaks.

4.1.1 Impact

The *Academic impact* metric reflects the **annual citations per peer-reviewed publication older than 1 year** (AC_{PRP}) and is derived via the annual mean peer-reviewed publication citations over all academic years older than 1 year ($C_{PRP,ann}$) normalised to the number of peer-reviewed publications older than 1 year (O_{PRP}).

$$C_{PRP,ann} = \frac{C_{PRP}}{\max(1, AA)} \quad (1)$$

$$ProAc^{RQ} = AC_{PRP} = \frac{C_{PRP,ann}}{O_{PRP}} \quad (2)$$

where C_{PRP} is the total number of peer-reviewed publications and AA is the number of academic years excluding year-long career breaks.

- **Abbreviation:** $ProAc^{RQ}$
- **Axis limits:** $0 - 20$ citations
- **Point of proven successful (PPS):** 20 citations per year and publication are assumed sufficient to underline the need for the author's research output.
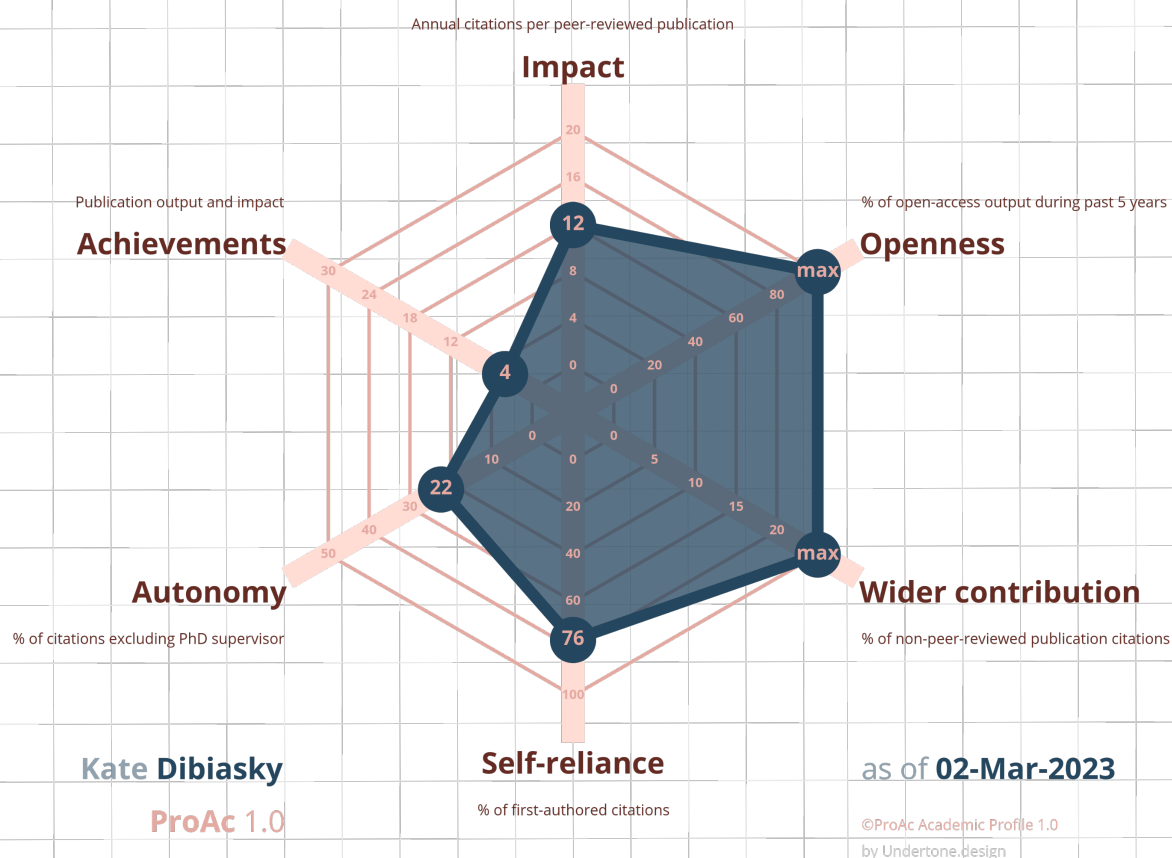
Figure 1: ProAc graphic design. Key graphic principles effectively emphasise the academic profile. The visual profile is designed to be universally accessible, directly comparable, and widely compatible. The design is focussed to represent much information with little graphic clutter. Only colour-blind friendly colours are applied (from Crameri, 2018, conserving readability even in black&white prints). An optional dark mode enables effective representation on dark backgrounds (such as presentation slides).

- **Intentionally designed for** cultivating higher research quality and avoiding the incentive for unnecessarily high research quantity.
- **Potential improvements** are limiting it to the last 5 (or so) years to reduce impacting the metric with irrelevant past academic work and to encourage improvement of research quality on the short term.

4.1.2 Self-reliance

The *Academic self-reliance* metric reflects the **fraction of first-authored citations** (fC_{FA}) and is derived via the fraction of the total first-authored citations (C_{FA}) relative to the total number of citations (C_{Total}).

$$ProAc^{IND} = fC_{FA} = \frac{1}{C_{Total}} * C_{FA} \tag{3}$$

where all citations include also non-peer reviewed publications (e.g., software, datasets, blog posts).

- **Abbreviation:** $ProAc^{IND}$
- **Axis limits:** $0 - 100\%$
- **Point of proven successful (PPS):** 80% of citations are assumed sufficient to underline strong academic self-reliance.
- **Intentionally designed for** acknowledging the effort of a first-authorship and to minder the temptation for unwarranted co-authorship.

4.1.3 Autonomy

The *Academic autonomy* metric reflects the **fraction of citations excluding the PhD supervisor** (fC_{AUT}) and is derived via the total independent (i.e., excluding PhD supervisor) citations (C_{AUT}) relative to the total number of citations (C_{Total}).

$$ProAc^{AUT} = fC_{AUT} = \frac{1}{C_{Total}} * C_{AUT} \tag{4}$$

where all citations include also non-peer reviewed publications (e.g., software, datasets, blog posts).

- **Abbreviation:** $ProAc^{AUT}$
- **Axis limits:** $0 - 50\%$
- **Point of proven successful (PPS):** 50% of citations derived from publications without PhD supervisor are assumed to prove sufficient academic autonomy.
- **Intentionally designed for** acknowledging academic independency and to reduce dependency on potent PhD supervisors to kick-off a successful career.

4.1.4 Wider contribution

The *Wider contribution* metric reflects the non-peer-reviewed publication impact in form of the **fraction of non-peer-reviewed publication citations** (fC_{NPRP}) and is derived via the fraction of the total peer-reviewed publication citations (C_{PRP}) relative to the total number of citations (C_{Total}).

$$ProAc^{INV} = fC_{NPRP} = 1 - \frac{1}{C_{Total}} * C_{PRP} \tag{5}$$

where C_{Total} includes also non-peer reviewed publications (e.g., software, datasets, blog posts).

- **Abbreviation:** $ProAc^{INV}$
- **Axis limits:** $0 - 25\%$
- **Point of proven successful (PPS):** 25% of citations are assumed sufficient to underline strong academic involvement beyond peer-reviewed publication.
- **Intentionally designed for** acknowledging academic involvement beyond publishing peer-reviewed papers and to encourage and improve critical academic duties like public outreach, teaching, toolbox development, editing, and convening.

4.1.5 Openness

The *Scientific openness* metric reflects the **fraction of open-access output during the last 5 years** (fO_{OA}) and is derived via the open-access (i.e., including non-peer reviewed) output of the last 5 years (O_{OA}) relative to the total (i.e., including non-peer reviewed) output of the last 5 years (O_{Total}).

$$ProAc^{OA} = fO_{OA} = \frac{1}{O_{Total}} * O_{OA} \tag{6}$$

where all output measures taken here include also non-peer reviewed publications (e.g., software, datasets, blog posts).

- **Abbreviation:** $ProAc^{OA}$
- **Axis limits:** $0 - 100\%$
- **Point of proven successful (PPS):** 100% of recent open-access output is assumed showing full commitment. Science should be fully open-access and there is no valid reason for research behind paywalls.
- **Intentionally designed for** acknowledging recent academic open-access efforts and to foster a systematic change towards an open academic environment.

4.1.6 Achievements

The *Academic achievements* metric reflects the past achievements in form of the **total publication output and impact** (*h*-index;

see also Section 2) and is derived via the total (i.e., including non-peer reviewed) output (O_{Total}). It represents the maximum value of h such that an author has published at least h papers that have each been cited at least h times (Hirsch, 2005). If the function f represents the academic publications ordered in decreasing order from most citations to least citations, then the h-index is calculated as follows:

$$h\text{-}index(f) = \max\{i \in \mathbb{N} : f(i) \geq i\} \qquad (7)$$

- **Abbreviation:** $ProAc^{h\text{-}index}$
- **Axis limits:** $0 - 30$
- **Point of proven successful (PPS):** 30 is assumed sufficient to indicate a strong achievement in peer-reviewed publication output and impact. Most, if not all, academics under some kind of evaluation (awards not included) have an index of 30 or lower.
- **Intentionally designed for** acknowledging output and impact of published academic output.

4.2 Graphic design of ProAc

A common bottleneck to fairly evaluate academics is the little time that is generally available for funders, panellists, or employers to get to know about the relevant details of the applicants. Recent suggestions for improving evaluation objectivity, like a narrative curriculum vitae (CV), seem therefore ineffective. Graphics are so common in science because they can transfer information accurately and effectively if done right (Crameri, Shephard, and Straume, 2022). A visual representation of the academic profile seems therefore optimal.

The graphic representation of the ProAc profile is carefully developed based on state-of-the-art graphic principles. It provides a strong visual imprint of an academic's profile and allows straightforward comparison between two or more of them (see Figure 2). As an academic profile is mainly directed at evaluators, its visual hierarchy is as follows (from most apparent to least apparent):

1. **Profile graph.** The spider graph effectively brings together multiple dimensions forming a characteristic remarkable shape. The graph is the key feature and therefore made to stand out with bold and dark lines providing the strongest lightness contrast to the light background.
2. **Academic's name and profile creation date.** The second visual feature in the graphic hierarchy is the information about the academic for which the profile is made, and the date of creation. Both are visually linked through colour continuity. The name avoids confusion when comparing multiple profile graphs and the date clarifies the point in time of the ever-evolving, given academic career.

3. **Individual metric labels.** All individual metrics of the profile are labelled with the most basic description. This is important to facilitate reading the profile effectively. A closer look subsequently reveals more details about the individual metrics and what they are measuring.
4. **Individual numerical scores.** The actual scores for each metric are clearly given by numbers and put into context in combination with the underlying scale. The colour contrast between inside (achieved) and outside (targeted) is graphically represented by the colour contrast, which highlights the achieved part of the scales.
5. **The version of the represented ProAc profile.** The ProAc profile will undergo future updates to improve the profile itself and to adjust to the evolving academia and data availability (see Figure 3).

This visual hierarchy makes the profile intuitive to read. It is created by variable font sizes and contrasts in both colour and lightness between individual graphic elements and the background.

High-contrast graphic elements (where necessary) and CVD-friendly colour palettes (e.g., Crameri, 2018) are used. ProAc visuals are therefore readable for all academics who can see, including those with any type of colour-vision deficiency (CVD; Crameri, Shephard, and Heron, 2020), and even readable in black and white prints.

The key graph is standardised (across individual profiles), clear, and simple enough to be remembered and comparable across individual sheets of papers (e.g., for comparing two CVs next to each other). Individual axes displaying ProAc metrics show a limited range (where sensible) to provide clear visual differences between alternating values. Comparing individual ProAc profiles is therefore accurate and simple (see Figure 2)

4.3 Creating and using ProAc

ProAc is not only be used by individual academics, but also created. Creating an individual ProAc profile is simple. The publication record in tabular form is the only preset needed. It follows a predefined design and CSV format (available and described in Crameri, 2023b), which can be created with multiple common spreadsheet software tools. This solution is effortless, especially because it is, amongst academics, already common to keep track of the publication record and publication record in tabular form might often already exist.

From the CSV file, the creation of the ProAc profile is a matter of clicks: The ProAc toolbox on www.fabiocrameri.ch/proac performs extensive diagnostics and creates the application-ready visual profile fully automatically.

4.3.1 ProAc toolbox

The toolbox to create a personal academic profile includes an input table template for the personal academic data and an open-access
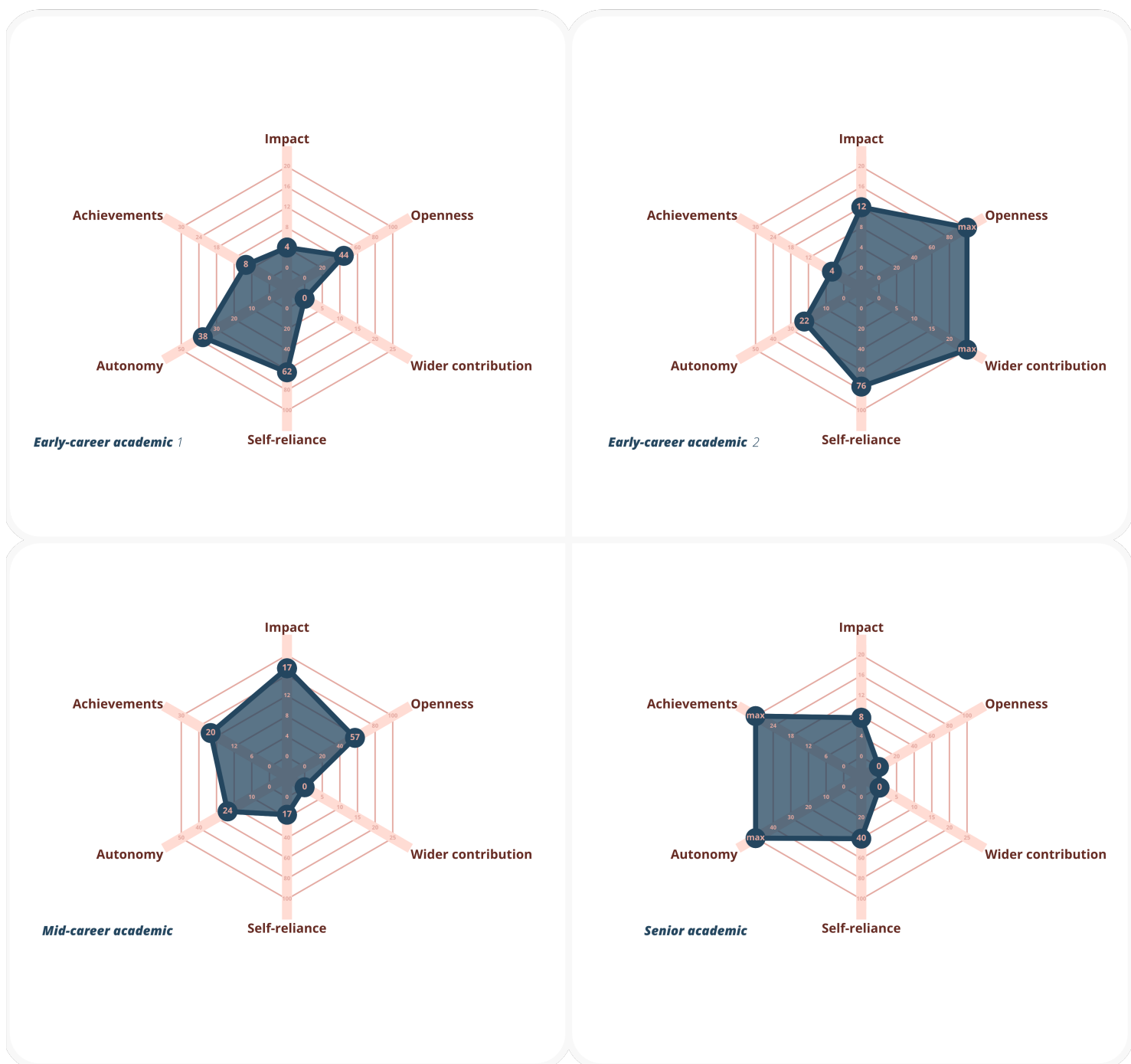
Figure 2: Comparing ProAc profiles. No more 'better or worse': Instead of ranking, the graphic ProAc profile is designed for purpose-focused evaluation. An early-career profile does not necessary look "worse" than a mid-career or senior profile. The 1-order visual impression can, for example, be more different between same stage academics than between early- and late stage academics. Overall, the ProAc profile facilitates and speeds up objective scientific evaluation.
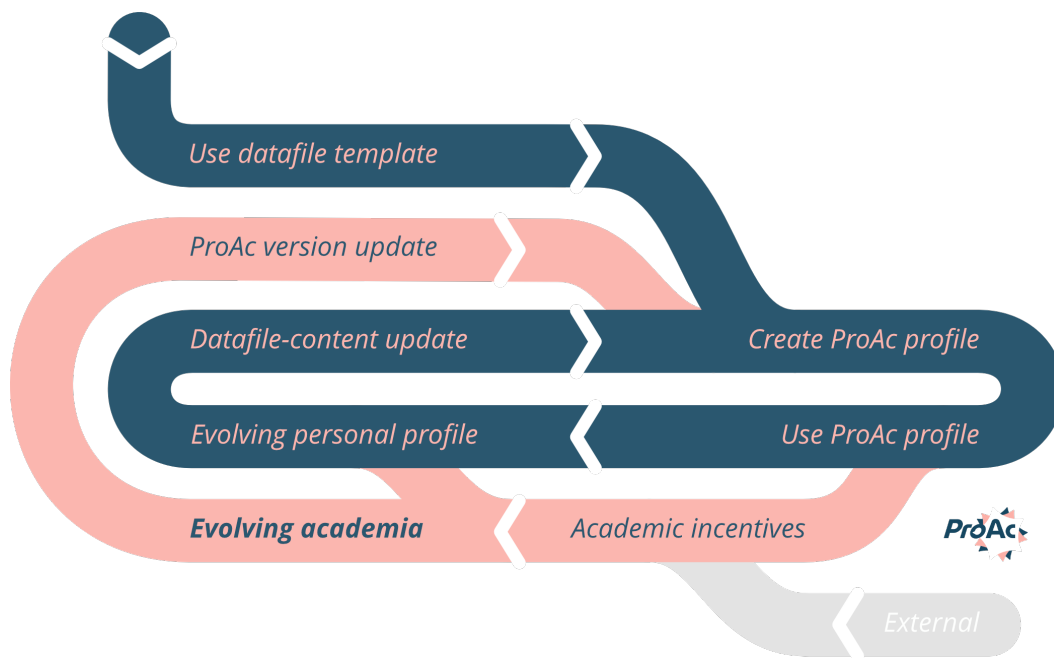
Figure 3: ProAc revolution. The ProAc profile is created by filling out the datafile template (from Crameri, 2023b) with the personal academic data, and using it to automatically create the visual profile (via www.fabiocrameri.ch/proac). By using the ProAc profile, one creates multiple good academic incentives (such as the push to make research open-access). The impacts of these academic incentives are twofold, leading to an evolution of the academic work environment (such as open-access journals becoming the standard) and an evolution of individual academic efforts (such as an academic openly sharing more methodologies), respectively. These positive personal (blue) and academic (pink) feedback cycles are maintained by continuous adjustments and improvements of the ProAc profile design through version updates.

software to create the graphic profile. The ProAc toolbox (Crameri, 2023b) is available via www.fabiocrameri.ch/proac. Version 1.0 software is fully open-access for universal usability. The toolbox aims for an effortless use by individual academics. Similarly, the machine-readable input table (Figure 4) is carefully designed to make it easy and effortless to collect all necessary data (as listed in Table 1). Once created, and regularly updated, it even offers the opportunity to track the individual academic achievements through time. The table simply has to be created in, or later converted to, a CSV format to be readable by the ProAc software.

4.3.2 Application

The ProAc profile is not intended to replace a listed or narrative curriculum vitae (CV), but aims to complement it with an objective academic characterisation and evaluation. Under all circumstances, it must be kept in mind that the ProAc profile is an incomplete representation of an academic. Important academic skills like teaching, editorial efforts, or social-media outreach are, in the current version, not represented.

The final graphic ProAc profile (Figure 1) will fit on half an A4 page in a standard CV. Moreover, the ProAc profile, and its corresponding graphs, will be suitable to provide an effective overview on individual academics on professional webpages.

4.4 Versioning and future updates of ProAc

To adjust to the ever-evolving academic landscape, ProAc is designed to be updated regularly with adjusted or different sets of metrics. ProAc is versioned and its development fully transparent (see Crameri, 2023b). The software package, including its profile metrics and graphic design, is open for constructive comments by the academic community via www.fabiocrameri.ch/proac. Future updates to the ProAc toolbox will be released via the permanent storage solution (on https://doi.org/10.5281/zenodo.7691086) provided by Zenodo, and communicated via www.fabiocrameri.ch/proac. This manuscript, Crameri (2023a), describing the toolbox and its content will be updated accordingly.

4.5 Future direction of ProAc

At the time of publication, ProAc covers and represents important additional key academic efforts in contrast to traditional methods, like open-access support and software development and distribution (Caroline Jay, 2021). Further crucial contributions like public outreach, teaching, or supervision are not yet covered by the academic profile due to the missing data and/or suitable metrics. Including them progressively to ProAc over time is sensible and not a drawback at all as currently, these efforts are covered elsewhere in CVs submitted for evaluation.

Tag	Year	Kind	First authored	Single authored	PhD publication	Including PhD supervisor	Publisher	Open access	Link	Full reference	Citations	Title
Dibiasky and Mindy (in prep.)	2023	Pre-print paper	1	0	0	1	Annales Geophysicae		1 https://doi.org/10.31223/X51P78	Dibiasky, K. and R. Mindy (2023, pre-print), Why humanity does not like to look up, EarthArXiv, doi:10.31223/X51P78	0	Why humanity does not like to look up.
Dibiasky et al. (2022)	2022	Peer-reviewed paper	1	0	0	1	Global and Planetary Change		1 https://doi.org/10.5281/zenodo.6569100	Dibiasky, K., R. Mindy, and T. Oglethorpe (2021), No, really, look up!, Global and Planetary Change, doi:10.5281/zenodo.6569100	7	No, really, look up!
Dibiasky et al. (2021)	2021	Peer-reviewed paper	1	0	1	1	Nature Communications		1 https://doi.org/10.1038/s41467-020-19160-7	Dibiasky, K., and R. Mindy (2021), Look up!, Nature Communications, doi:10.1038/s41467-020-19160-7	34	Look up!
Dibiasky (2021b)	2021	News & Views	1	1	0	0	Nature Geoscience		1 https://dx.doi.org/doi:10.1038/ngeo2941	Dibiasky, K. (2021b), Planetary Tectonics: Rethinking the danger of unknown near comets, edited by H. Gibson and G. D'Souza, EGU-GeoLog Blog, doi:10.1038/ngeo2941	3	Planetary Tectonics: Rethinking the danger of unknown near comets
Dibiasky (2020b)	2020	Blog post	1	1	0	0	EGU Geolog		1 https://blogs.egu.eu/divisions/gd/2018/05/09/to-serve-geoscientists/	Dibiasky, K. (2020b), Serving unknown near comets, edited by H. Gibson and G. D'Souza, EGU-GeoLog Blog	0	Serving unknown near comets
Dibiasky (2020c)	2020	PhD Thesis	1	1	1	0	ETH Zurich		1 https://dx.doi.org/doi:10.3929/ethz-a-009954311	Dibiasky, K. (2020b), A toolbox for observing comets with near-Earth orbits, PhD Thesis, ETH Zurich, doi:10.3929/ethz-a-009954311	2	A toolbox for observing comets with near-Earth orbits
Dibiasky (2020, CoFi)	2020	Community software	1	1	1	0	Zenodo		1 https://dx.doi.org/doi:10.5281/zenodo.1243862	Dibiasky K. (2020), CoFi: Comet Finder (Version 1.0.0) [Software]. Zenodo. https://dx.doi.org/doi:10.5281/zenodo.1243862	22	CoFi: Comet Finder (Version 1.0.0)
Mindy and Dibiasky (2020, Near Comet Database)	2020	Community database	0	0	1	1	Zenodo		1 http://doi.org/10.5281/zenodo.3756716	Mindy, R. and K. Dibiasky (2020), Near Comet Database (Version 1.0.0) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.3756716	28	Near Comet Database (Version 1.0.0)
Dibiasky (2020, s-ink)	2022	Community website	1	1	0	0		1	s-ink.org	s-ink.org	0	s-ink.org

Figure 4: ProAc input table design. A simple machine-readable table (template available from Crameri, 2023b) listing the personal academic publication record is used as the only input to create a personal ProAc profile.

Table 1: ProAc input data. Data representing the personal academic publication record necessary for ProAc profile version 1.0 (Crameri, 2023b) and optional data for future-proofing.

	Description	Type
Year	The publication year of the given publication	Integer
Kind	The kind of publication, which can be *"Peer-reviewed paper"*, *"Pre-print paper"*, *"News & Views"*, *"Blog post"*, *"PhD thesis"*, *"MSc thesis"*, *"BSc thesis"*, *"Community software"*, *"Community database"*, *"Community webpage"*, or similar	String
First authored	Whether the given publication is first authored or not	Binary
Including PhD supervisor	Whether the given publication includes the PhD supervisor as (co-) author or not	Binary
Open access	Whether the given publication is published open-access or not	Binary
Citations	The current number of citations of the given publication	Integer
Tag	Short, unique citation of the given publication	String
Title	Title of the given publication	String
Publisher	Publisher of the given publication	String
Full reference	Bibliographic reference of the given publication	String
Link	Web link to the given publication	String
Single authored	Whether the given publication is single authored or not	Binary

The prospect of a more complete academic visual profile, including outreach, teaching and supervision, should entice further efforts to build the necessary framework to measure these critical academic achievements numerically. Such potential avenues were suggested already. Public outreach, for example, could be represented to some degree by metrics like the "Kardashian index" (Hall, 2014), taking the number of social media followers into account.

Even though certain metrics or data are currently not readily available, there is ongoing efforts to build frameworks for it. One example is the work around the "Engagement Index" suggested by Loïc Piret. At any time, ProAc will be able to expand its current coverage and improve.

4.6 Advantages of ProAc

Besides characterising an academic's research output and impact more accurately (e.g., through measuring first-order individual impact and academic independency), ProAc is intentionally designed to shine light on invaluable academic efforts like public outreach, scientific tool and methodology design, and open-access efforts. If possible, it will make other aspects like teaching, social-media outreach, peer-review and editorial efforts accessible in the future, too. As such, it introduces multi-faceted incentives that open up gateways towards important academic advances.

- **More effective personal academic growth.** A personal profile directly highlights academic shortcomings and achievements and can be used to see potential, and track progress.
- **More effective academic teams.** ProAc profiles will make it easier to assemble more diverse academic teams that foster teamwork and reach a value beyond the sum of all individuals. For example, one team member's outreach skills can add value to another one's research outcome, or another one's strong academic independency can help direct another one's high-quality but undirected research towards more impact.
- **High-quality instead of high-quantity publication.** Through widening the academic evaluation criteria beyond research output and impact, ProAc will help to reduce unnecessary publication pressure and destructive competition between peers.
- **More welcoming academic work environment.** Reducing publication pressure and academic competition can lead to more supportive and overall healthier academic teams. The better climate at the workplace will likely reduce unnecessary academic brain-drain.
- **Fairer and more transparent grant and job distribution.** The more objective academic evaluation through a standardised academic profile is more transparent for applicants, who then can better judge their chances of success in advance and whether they want to invest precious research time on grant writing and job applications, or not.

- **More time-effective academic assessment.** Current distribution of academic research grants and jobs is almost exclusively based on time-consuming academic assessment (for applicants, reviewers, and panel members alike). ProAc facilitates presenting, comparing, and judging academic skills and achievements. It also makes everything faster, which preserves valuable research time.

All above points combined have the potential to create a more effective and diverse academia as a whole in which individual academics do not shy back from important methodological investments, science outreach, or open-access tool development.

5 Closing

Evaluating academics is not easy, but is currently the standard, time-intensive way to distribute the limited funds. The current academic ranking system, used for the evaluation, is largely based on a single, one-dimensional metric (Section 1) and thereby both incomplete and destructive to individual academics and science as a whole (Section 2). Current promises to incorporate a more complete range of academic skills and achievements under consideration of differing work-life balances are hardly translating into the actual evaluation for various reasons: Evaluators are not objective, not alike each other, and generally not trained (if at all instructed) for the task, and the evaluation time is limited.

A graphic profile is a time-effective way to communicate skills and past achievements, which is why they are commonly used to characterise other professionals than academics, for example athletes or politicians. ProAc is the academic version of graphic profiling. The ProAc profile is not a complete representation of an academic, and never will be. However, if used responsibly, it has the potential to make scientific evaluation more objective and transparent, fairer to applicants, and more time effective and easier to evaluators than any current solution. One critical necessity is that institutions, funders and employers, make use of the academic profile. A widespread inclusion of the graphic profile into individual academic CVs will help them to take this step forward.

Bibliography

Anauati, Victoria, Sebastian Galiani, and Ramiro H Gálvez (2016). "Quantifying the life cycle of scholarly articles across fields of economic research". In: *Economic Inquiry* 54.2, pp. 1339–1355.

Anderson, Thomas R., Robin K. S. Hankin, and Peter D. Killworth (2008). "Beyond the Durfee square: Enhancing the h-index to score total publication output". In: *Scientometrics* 76.3, pp. 577–588. DOI: 10.1007/s11192-007-2071-2. URL: https://doi.org/10.1007/s11192-007-2071-2.

Baker, Monya (2016). "1,500 scientists lift the lid on reproducibility". In: *Nature* 533.7604, pp. 452–454. DOI: 10.1038/533452a. URL: https://doi.org/10.1038/533452a.

Bartneck, Christoph and Servaas Kokkelmans (2011). "Detecting h-index manipulation through self-citation analysis". In: *Scientometrics Scientometrics* 87.1, pp. 85 –98. DOI: 10.1007/s11192-010-0306-5. URL: https://akjournals.com/view/journals/11192/87/1/article-p85.xml.

Batista, Pablo D, Mônica G Campiteli, and Osame Kinouchi (2006). "Is it possible to compare researchers with different scientific interests?" In: *Scientometrics* 68.1, pp. 179–189.

Bornmann, Lutz and Hans-Dieter Daniel (2008). "What do citation counts measure? A review of studies on citing behavior". In: *Journal of Documentation* 64.1, pp. 45–80. DOI: 10.1108/00220410810844150. URL: https://doi.org/10.1108/00220410810844150.

Bornmann, Lutz et al. (2011). "A multilevel meta-analysis of studies reporting correlations between the h index and 37 different h index variants". In: *Journal of Informetrics* 5.3, pp. 346–359. ISSN: 1751-1577. DOI: https://doi.org/10.1016/j.joi.2011.01.006. URL: https://www.sciencedirect.com/science/article/pii/S1751157711000071.

Caroline Jay Robert Haines, Daniel S. Katz (2021). "Software Must be Recognised as an Important Output of Scholarly Research". In: *International Journal of Digital Curation* 16.1, p. 6.

Connor, J. (2011). "Google Scholar Citations Open To All". In: *Google Scholar Blog*.

Crameri, Fabio (2018). *Scientific colour maps*. Zenodo. DOI: 10.5281/zenodo.1243862. URL: https://www.doi.org/10.5281/zenodo.1243862.

– (2023a). *Multi-metric academic profiling with ProAc*. Zenodo. DOI: 10.5281/zenodo.4899015. URL: https://www.doi.org/10.5281/zenodo.4899015.

– (2023b). *ProAc visual academic profile*. Zenodo. DOI: 10.5281/zenodo.7691086. URL: https://www.doi.org/10.5281/zenodo.7691086.

Crameri, Fabio, Grace E Shephard, and Philip J Heron (2020). "The misuse of colour in science communication". In: *Nature Communications* 11.1, p. 5444. DOI: 10.1038/s41467-020-19160-7. URL: https://doi.org/10.1038/s41467-020-19160-7.

Crameri, Fabio, Grace E. Shephard, and E. O. Straume (2022). "Effective high-quality science graphics from s-Ink.org". In: *EarthArXiv*. DOI: 10.31223/X51P78. URL: https://doi.org/10.31223/X51P78.

Csajbók, Edit et al. (2007). "Hirsch-index for countries based on Essential Science Indicators data". In: *Scientometrics* 73.1, pp. 91 –117. DOI: 10.1007/s11192-007-1859-9. URL: https://akjournals.com/view/journals/11192/73/1/article-p91.xml.

Ferrara, Emilio and Alfonso E Romero (2013). "Scientific impact evaluation and the effect of self-citations: Mitigating the bias by discounting the h-index". In: *Journal of the American Society for Information Science and Technology* 64.11, pp. 2332–2339.

Forrester, Nikki (2023). "Fed up and burnt out: 'quiet quitting' hits academia". In: *Nature* 615, pp. 751–753. DOI: 10.1038/d41586-023-00633-w. URL: https://doi.org/10.1038/d41586-023-00633-w.

Gálvez, Ramiro H. (2017). "Assessing author self-citation as a mechanism of relevant knowledge diffusion". In: *Scientometrics* 111.3, pp. 1801–1812. DOI: 10.1007/s11192-017-2330-1. URL: https://doi.org/10.1007/s11192-017-2330-1.

Glänzel, Wolfgang (2006). "On the opportunities and limitations of the H-index". In: *Science focus*.

Hall, Neil (2014). "The Kardashian index: a measure of discrepant social media profile for scientists". In: *Genome Biology* 15.7, p. 424. DOI: 10.1186/s13059-014-0424-0. URL: https://doi.org/10.1186/s13059-014-0424-0.

Hawkins, Ed (Mar. 2015). "Scrap rainbow colour scales". In: *Nature* 519, 291 EP –. URL: https://doi.org/10.1038/519291d.

Hirsch, J. E. (2005). "An index to quantify an individual's scientific research output". In: *Proceedings of the National Academy of Sciences* 102.46, pp. 16569–16572. ISSN: 0027-8424. DOI: 10.1073/pnas.0507655102. eprint: https://www.pnas.org/content/102/46/16569.full.pdf. URL: https://www.pnas.org/content/102/46/16569.

– (2020). "Superconductivity, what the H? The emperor has no clothes". In: *arXiv* 2001.09496.

King, Molly M. et al. (2017). "Men Set Their Own Cites High: Gender and Self-citation across Fields and over Time". In: *Socius* 3, p. 2378023117738903. DOI: 10.1177/2378023117738903. URL: https://doi.org/10.1177/2378023117738903.

Kinney, A. L. (2007). "National scientific facilities and their science impact on nonbiomedical research". In: *Proceedings of the National Academy of Sciences* 104.46, pp. 17943–17947. ISSN: 0027-8424. DOI: 10.1073/pnas.0704416104. eprint: https://www.pnas.org/content/104/46/17943.full.pdf. URL: https://www.pnas.org/content/104/46/17943.

Park, Michael, Erin Leahey, and Russell J. Funk (2023). "Papers and patents are becoming less disruptive over time". In: *Nature*

613.7942, pp. 138–144. DOI: `10.1038/s41586-022-05543-x`. URL: `https://doi.org/10.1038/s41586-022-05543-x`.

Raan, Anthony F. J. van (2006). "Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups". In: *Scientometrics* 67.3, pp. 491–502. DOI: `10.1556/Scient.67.2006.3.10`. URL: `https://doi.org/10.1556/Scient.67.2006.3.10`.

Ruane, Frances and Richard Tol (2008). "Rational (successive) h-indices: An application to economics in the Republic of Ireland". In: *Scientometrics* 75.2, pp. 395–405. DOI: `10.1007/s11192-007-1869-7`. URL: `https://akjournals.com/view/journals/11192/75/2/article-p395.xml`.

Schooler, Jonathan W. (2014). "Metascience could rescue the 'replication crisis'". In: *Nature* 515.7525, pp. 9–9. DOI: `10.1038/515009a`. URL: `https://doi.org/10.1038/515009a`.

Sekercioglu, Cagan H. (2008). "Quantifying Coauthor Contributions". In: *Science* 322.5900, pp. 371–371. DOI: `10.1126/science.322.5900.371a`. eprint: `https://www.science.org/doi/pdf/10.1126/science.322.5900.371a`. URL: `https://www.science.org/doi/abs/10.1126/science.322.5900.371a`.

Sidiropoulos, Antonis, Dimitrios Katsaros, and Yannis Manolopoulos (2007). "Generalized Hirsch h-index for disclosing latent facts in citation networks". In: *Scientometrics* 72.2, pp. 253–280. DOI: `10.1007/s11192-007-1722-z`. URL: `https://akjournals.com/view/journals/11192/72/2/article-p253.xml`.

Van Noorden, Richard (2020). "Highly cited researcher banned from journal board for citation abuse". In: *Nature* 578.7794, pp. 200+. URL: `https://link.gale.com/apps/doc/A660675803/AONE?u=anon~fb182d4a&sid=googleScholar&xid=1f8d2248`.

Wilhite, Allen W. and Eric A. Fong (2012). "Coercive Citation in Academic Publishing". In: *Science* 335.6068, pp. 542–543. DOI: `10.1126/science.1212540`. eprint: `https://www.science.org/doi/pdf/10.1126/science.1212540`. URL: `https://www.science.org/doi/abs/10.1126/science.1212540`.

Yong, Alexander et al. (2014). "Critique of Hirsch's citation index: A combinatorial Fermi problem". In: *Notices of the AMS* 61.9, pp. 1040–1050.