# Proposal of a Visual Collaborative Review Platform for Improving Peer Evaluation in Medical Diagnostics

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## ABSTRACT

This is a proposal for a concept called PiePlate, a digital icon to displays the current state of peer-review *facets* that have been assessed on a research paper. The "peer-reviewed" stamp often serves as a crude quality filter, offering only the binary option of peer-reviewed and not peer-reviewed. PiePlate would give readers more peer review-based options for understanding the merits of a paper, regardless of where or how (or if) a paper was published. PiePlate enables reviewers to contribute an assessment on any single facet, which may be especially useful when a reviewer's skill set can be applied toward one area of a paper, but not to the others. Two major areas of work are needed to bring this project together: i.) decoupling peer-review into a standardized taxonomy of checks (facets), and ii.) building a system to collect and display appropriate groupings of these facets per paper. This paper includes a summary of need, key precedents, a description of the basic design and functionality of PiePlate, incentives for users, and some other incentives and benefits, such as citing peer-reviewers.

## SUMMARY OF NEED

Peer-review is a publishing best practice, even with its many common criticisms such as unreliability and inconsistency, delay and expense, lack of accountability and risks of subversion, social and publication biases, lack of incentives, and wastefulness (Ross-Hellauer, 2017). Researchers in different career stages (early, mid, and late) and roles in publishing (reviewers, editors, and publishers) have been found to hold differing, even contradictory views of the purpose of peer-review (Severin & Chataway, 2020). Ambiguity about the purpose of peer-review may come from the journals themselves, with nearly a third of 171 major cross-disciplinary journals surveyed by Klebel, et. al. (2020) reporting they did not provide public information on the type of peer review used. Less than half of the 322 journals Hamilton, et. al. (2020) surveyed reported that they checked for plagiarism and, of the 107 highly-cited biomedical journals that responded to a survey by Hardwicke & Goodman (2020), 34% rarely or never used specialized statistical review, 34% used it for 10–50% of their articles, and only 23% used it for all articles.

Even with disagreement over what purpose peer-review serves and what checks it should consist of, the 'stamp' of peer-review provides many readers with a rudimentary filter that a paper has "convinced at least one relatively disinterested expert that the manuscript is worthy of public viewing" (Heesen & Bright, 2020). But trust in peer-review is eroded by retractions of articles published by high-impact peer-reviewed journals,[1] just as trust in the peer-review label is undermined by the presence of predatory publishers, which are outlets that make "misleading claims about the rigour of peer review" (Grudniewicz et. al., 2019). It is telling that a group attempting to define predatory publishing chose to omit *quality of peer review* from their criteria since they found that "many legitimate journals fail to make their peer-review processes sufficiently transparent, for instance by sharing peer reviewers' comments and other data" (Grudniewicz, 2019).

For decades, experiments have been undertaken to increase efficiency, transparency, and modularity in peer-review. Peer-review has expanded from the categories of blind peer-review

[1] Lu et. al (2013) found there to be higher rates of retraction in high-impact journals, although this may be due in part to higher numbers of readers giving these articles closer scrutiny, or a possible sign of editors inclined to retract.

and double-blind peer-review to more open versions of peer-review (Ross-Hellauer, 2017).[2] A so-called "revolution" phase in open peer-review experimentation occurred during the five-to-ten-year period prior to 2017, precipitated by calls for "systemic changes in the way that scientific research outputs are evaluated" on one hand, and "advances in Web-based technologies" on the other hand (Tennant, et. al., 2017).[3] In early 2019, ASAPbio unveiled a project called ReimagineReview[4] where leaders of peer-review experiments were able to share information about their projects.[5]

When COVID-19 reached pandemic level in March 2020, the research community's ability to quickly filter a large corpus of literature became a global health imperative. The biology preprint server run by Cold Springs Harbor Laboratory, bioRxiv, took on several crowdsourcing experiments to quickly sort the relevance and importance of papers. A typical landing page for a COVID paper on bioRxiv was likely to be populated with a feed of tweets mentioning the paper, a Disqus comment section, a side panel with cite-able referee reports and annotations from independent review sites like Review Commons, along with a link to the most current version of the paper. Readers who accessed the PDF of a bioRxiv-hosted preprint from somewhere like Google Scholar may not have had any awareness of these auxiliary conversations.

By late-2020, the natural sciences journal eLife noted that their authors were embracing the use of preprint repositories like bioRxiv and announced a policy shift to exclusively review works first released as preprints. The journal planned to refocus their "editorial processes away from deciding what papers should be published," to help end "the absurd process of bouncing from

[2] In January 2021, the International Association of Scientific Technical and Medical Publishers will begin a pilot with publishers to implement a proposed Standard Taxonomy for Peer Review (Jones, 2020). The taxonomy has proposed to "identify and standardise definitions and terminology in peer review practices in order to help align nomenclature" as more publishers adopt new, open models of review, which may "enable the community to better assess and compare peer review practices between different journals" (Jones, et. al., 2020).

[3] Examples of these experiments identified by Tennant, et. al. (2017) include PLOS's introduction of commenting on papers, BMJ's Rapid Responses, cross publisher annotations platforms (PubPeer, PaperHive). Journals experimented by exclusively conducting review on manuscripts which were already made public (F1000, The Winnower). Services popped up that allow reviewers to claim credit for reviews (Publons, Academic Karma). Other experiments attempted to standardize pre-publication review forms to aid portability across publishers (RUBRIQ, Peerage of Science), or even provide metrics about the number of reviewers a paper received and the level of expertise of the reviewers (pre-SCORE).

[4] https://asapbio.org/launching-reimaginereview

[5] By the end of November 2020, the project had collected 49 peer-review experiments (https://web.archive.org/web/20201130125233/http://reimaginereview.asapbio.org/explore/).

journal to journal until a paper is accepted." eLife would also "move towards the rapid posting of all reviews, irrespective of the associated publishing decision," which would make it more challenging for authors to "permanently avoid dealing with issues that may have arisen during" review at eLife (Eisen, et. al., 2020).

eLife editor-in-chief Michael Eisen also co-founded the PLoS (Public Library of Science). Priem & Hemminger (2012) described PLoS as an early example of how some of the certification sub-functions performed by a traditional journal could be decoupled from each other. The PLoS "policy of unloading copyediting to authors" was a "key precedent" toward decoupled journals, where different knowledge production services were overlaid on top of archives (Priem & Hemminger, 2012). Ginsparg (1996) imagined that grades for papers "according to overall importance, quality of research, or other useful criteria" could be one type of information overlay service.

## DECOUPLING AS A BROADER TREND

Decoupling concepts into modular sub-concepts is a broad reform trend in scholarly communication. For example, CRediT (Contributor Roles Taxonomy) decouples the concept of the author into a descriptive set of 14 roles "typically played by contributors to scientific scholarly output" (https://casrai.org/credit/),[6] benefitting researchers by drawing "attention to their specific contributions" (Allen, et. al., 2014).[7] In similar fashion, CiTO (Citation Typing Ontology) decouples reference citations from a monolithic conception of attention currency into an ontology of 23 machine readable relationships between citing and cited document (Shotton, 2010).[8] The San Francisco Declaration on Research Assessment (https://sfdora.org/read/) can be read as an attempt to decouple research assessment practice, as they advocate for funding agencies and institutions to "assess research on its own merits rather than on the basis of the journal in which the research is published." Lastly, Priem, Taraborelli, Groth, & Neylon (2010) described the scientific article itself as an object which could be decoupled into smaller cite-able

[6] TaDiRize was a project similar to CRediT, which sought to "examine the expanding model of contributorship in the humanities" (Mangiafico, 2015).
[7] An app called tenzing is being developed to allow researchers to indicate at the start of a project which of the 14 CRediT categories they intend to contribute toward (Holcombe, A. O., Kovacs, M., Aust, F., & Aczel, B., 2020).
[8] New tools, such as scite.ai, use machine learning to automatically detect the citation relationship in published works from a simplified list (support, mentioning, or contradicting).

units, each reviewable through crowdsourcing from a wide variety of sources like Twitter, blogs, and readership statistics in reference management systems.

Decoupling research components also encourages a "proliferation of open research platforms," writes Mirowski (2018). As Tennant, et. al. (2014) found, "numerous platforms providing decoupled peer review services" which were "largely non-interoperable" leaving most of the evaluation contributions created on their sites "difficult to discover, lost, or rarely available in an appropriate context or platform for re-use." Tennant, et. al. (2014) noted that Publons was the one platform they observed which had any "focus on aggregating" content from some of the available commenting services, making it the closest concept the author is currently aware of.

What is proposed in PiePlate is a *meta-scheme*[9] to encapsulate and represent all forms of peer-review and experimentation. Key features that differentiate PiePlate from Publons is that PiePlate is envisioned as an interoperable dynamic badge that follows papers (rather than being a standalone website), which records commenting and review histories (and invites future ones) at a decoupled, clarified, and comprehensive level.

Mirowski (2018) has critiqued the platform capitalization of open science, finding the primary pursuit to be "cost-cutting" through the capture of "freely donated labor which can later be turned into proprietary knowledge products" including "sites promoting radical collaboration" like Publons, Peerage of Science, and F1000. While cost-cutting and freely donated labor would certainly be involved it its production and sustaining work, one other differentiating factor between Publons (acquired by Clarivate in 2017) and PiePlate is possible if PiePlate were to be built with non-commercial funding secured for its infrastructure and support, in order that the service serve science, not shareholders.

## DESCRIPTION OF DESIGN AND FUNCTIONALITY

This paper proposes for a team in the open source / open knowledge community to build an overlay service to visually represent the real time peer-review status for any paper on a granular level, called PiePlate. In deference to the fact that journals vary in what checks they perform (significance, statistical checks, soundness, etc.), as well as the manner review is

[9] Priem & Hemminger (2012) describe the decoupled journal as a meta-scheme: "for creating a market to let peer review—and the journal's other functions—evolve.""

conducted (double-blind review, open review, post-publication review, etc.), this service is designed to be indiscriminate about which among these peer-review data points it collects (though other filters may apply). In exchange for an agnostic approach to peer-review formats, PiePlate will be exact in its representations of what checks have performed (*if* they have been performed), the content of these checks (*if* they are open), and the identity of the contributor who provided the checks (*if* they are named).

This service's visual representation allows users to understand, from a glance, the degree of review an article has undergone, regardless of how the article was discovered. If the concept of peer-review acts as a filter indicating that a paper has undergone some level of scrutiny, PiePlate will provide a reader with a more exact understanding of those levels. It also presents readers with the opportunity to provide a new assessment for any single facet of review that appears to be missing (or misguided in its current assessments). From this perspective, it is possible that manuscripts not formally published by a journal may undergo an equal or higher level of review than a manuscript which has been formally published. It is also possible for a researcher to cite a published paper based on a completely different set of peer-review assessments than those originally provided from a journal. PiePlate makes it possible for events like these to be adequately represented.

In operation, PiePlates are assigned to papers once they receive a doi. Newly assigned PiePlates begin as an all-white pie chart (like an empty pie dish), except for a variable number of slice marks, plus a blank slice to allow the recommendation for others. Each slice represents a single facet from a peer-review taxonomy of assessment functions. The group of facets assigned to a paper should be appropriate to the particulars of the paper. As facets receive assessments by users, that slice appears to fill in. When more than one reader contributes to any single facet, each is represented as a different *forkful*.[10]

The initial selection of facets assigned to a PiePlate is populated based on a checklist completed by authors, editors, or preprint server administrators, or by a machine learning application designed to detect claims and sections presented in an article (such as Scholarcy). Once the PiePlate is presented to the public, users can recommend new facets which may have been

[10] If a single reader were to contribute an assessment on all facets, their contribution could be displayed as a crust, encircling the whole pie chart; if multiple readers do so, there could be multiple crusts encircling the pie.

missed or the removal of irrelevant facets. Facets that are heavily dependent on each other could form a combined slice. Facets may be represented with larger sized slices either at the time they are assigned or through growth over time. For instance, if a serious flaw or act of misconduct in a particular facet becomes shown, which affects the validity of the rest of the paper, that slice could grow to take up a majority of the pie.

As a meta-scheme, PiePlate would not require journals to alter their peer-review formats, authors to alter their preferences for submission venue, or even for peer-reviewers to alter how they peer-review. However, reviewers invited by a journal to assess an unpublished paper could elect to use a custom template to identify matching PiePlate facets. (PiePlate would also import what a journal chooses to share openly generally, not just what they share with PiePlate in particular.) Journals with closed review comments, unnamed reviewers, or unclear policies over what their editorial & review process screen for will have PiePlates on their articles that reflect this. If a journal uses closed peer-review but does publicly list what checks their review covers in their policies, then the corresponding facets would list the journal itself as the source of these particular reviews, with an indication that the content of the review is unavailable.

PiePlate icons would ideally be embedded at the top of the document of a paper, as well as an addition to a cover page or article metadata page. The presence of a PiePlate icon might be comparable to an Altmetric donut or Creative Commons license. The duties for assigning a PiePlate could fall to a journal, preprint server, or standalone minting service. Embedding with Crossmark could be especially valuable when new or revised versions of a paper become available, or if the present paper becomes retracted. Multiple, interconnecting PiePlates could be generated as new versions of a manuscript are released.[11]

With the PiePlate icon included directly on articles, one of the largest potential user bases are those users who discovered the PiePlate service while reading articles in the normal course of their research. The most direct method to review would be a PiePlate form allowing users (verified with ORCID) to select the facet they wanted to provide assessment on and a free text

[11] Amherst College Press Director Mark Edgington presented a concept for interconnecting hexagonal icons meant to describe the stages of peer-review (ex. ‘double-blind by three reviewers’) a manuscript has undergone (https://www.charleston-hub.com/2018/11/peer-review-increasing-transparency-in-standards-and-practices/), which could serve as inspiration for how to represent micro reviews on facets across the record of versions (as informally dubbed and popularized by Jeroen Bosman & Bianca Kramer).

area to type in. However, if a paper is already connected to a reviewing or commenting service, the PiePlate icon simply acts as a second invitation to the reader to contribute to these other services. Open review sites working with PiePlate may enable a semi-structured format to allow reviewers to code their comments to match facets, like how *tenzing* hopes to enable use of CRediT during manuscript preparation.[12]

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The image of a pie plate has been chosen for this concept with novelty as key characteristic, to be memorable to potential users. A pie plate has a key number of metaphoric entailments that may be immediately obvious to a user or would be once explained. The icon itself is a *pie chart*, but calling it a *pie plate* entails that: a plate can be empty, partially full, or whole; that a whole plate of pie is better than an empty one; that a person usually consumes just one slice in a sitting; that a slice of pie may be shared by the forkful; and finally, that a single slice removed from the pie may reveal layers.

While a pie plate is described here, in practice, the instantiation could just as well be a grid chart made up with individual squares, each with their own layers beneath. Call it TiramisuReview. Whatever form the concept takes, the essential elements include a basic geometric shape that can be portioned into smaller uniform segments to represent different review facets of equal and unequal size.[13] Each of the individual visual segments that represent a facet (slices in the case of a pie chart, smaller squares in the case of a grid chart) would be independently viewable. When viewed independently, these slices would take on the shape of a vertical bar graph (much like pie layering) to represent when there is more than one reviewer contribution per facet.

## INCENTIVES TO PARTICIPATE

As researchers increasingly see unassessed facets on papers alongside a method to provide that assessment, the novelty of this proposition will inspire a variety of private incentives to participate. This is the rationale underlying my assertion that the technology of PiePlate is a

[12] Otherwise, reviews created for outlets like F1000's Open Peer Review (which appear as a sidebar that slides out on an article to reveal reviews from invited reviewers on different article versions), or the COVID-19 Rapid Review project at MIT (which treats reviews like very brief articles in their own right) could each be harvested by a natural language processing service to match facets, similar to how scite.ai matches citation sentiment.

[13] Consideration will also need to be given to making the service fully operable with text-readers for both accessibility and translation options.

match for the hurdle of social uptake. Below are scenarios describing how individuals may be self-motivated to contribute to PiePlate.

In positive cases, a reader may wish to make a genuine good faith recommendation to the author. Or an early reader may want to alert the research community about excellence in a particular facet in the hope that the other facets will quickly be vetted too. Senior researchers might use the venue to systematically provide constructive and positive (where warranted) comment on papers by early-career researchers as a potential way to advertise their own labs and programs to fresh talent, or simply in the name of professional service. In negative cases, it may be that a reader has uncovered a serious flaw in a paper's methodology, or a very incomplete literature review, or an unnamed conflict of interest. Rather than simply stewing in silence, airing the grievance on twitter, or awaiting a response from a journal, these readers can lodge their complaint as a constructively written review, that would be difficult for the authors or future readers to ignore.

The creators of machine learning-enabled services[14] might have incentive to participate in PiePlate as well. Entrepreneurs and web service developers could demo their tools capabilities by seeking out papers that lack review of a particular facet that their tool specialized in and providing a review. The idea of more automation in review work does, however, does raise the specter of the many creative ways that bad actors will be incentivized to misuse this system.

Auto-generated peer-reviews (Bartoli, 2016) or customer review mills (such as occurs on online shopping sites like Amazon) could be used to artificially inflate a researcher's own papers or bring down the reputation of competitors. Human and machine moderation would need to occur. Asking all contributors to the PiePlate system with ORCID would help defend against misuse, or at least make it more transparent when it did occur. This requirement could also bring further positive benefits for reviewers, by way of reputation enhancement.

Dr. Elizabeth Bik is an exemplar of so-called "super-spotters" of duplicated images in science papers who regularly post their finds "on Twitter and other online forums, in the process teaching others how to spot duplications and pressuring journals to investigate papers" (Shen, 2020). While Dr. Bik has already accumulated a reputation for her detection skills, others who

[14] Examples: A service like Codecheck (https://codecheck.org.uk/process/) could provide a review of a code facet in an article. An artificial intelligence service, such as one described by Graham, et.al. (2020), detecting when conflicts of interest exist could provide a review of a COI facet.

"work behind the scenes, publishing their findings in research papers and writing privately to journals" (Shen, 2020) might find their work having quicker results in a PiePlate scheme. Quickly marking new works which have engaged in research misconduct or other serious methodological flaws would have the laudatory effect of cutting down on the hundreds of new articles that researchers feel responsible for staying abreast of each year.

Over time, research communities might come to recognize the true value of a researcher who tells you which ten articles in a year you *do not* need to read, rather in comparison to the researcher who puts one more authored article on your stack. However, this change will not happen overnight, and as paper authorship remains a must for researchers, the potential to advertise oneself for recruitment could translate to an incentive to participate on PiePlate. This section concludes with a scenario that illustrates how facet assessment could translate to recruitment.

George is a new researcher with a clear knack for formal analysis. Annabel excels in methodology. Both George and Annabel have displayed their skill *and* collegiality in their many facet reviews on PiePlate. Meanwhile, senior researchers Tom and Henry have just acquired funding for their recently conceptualized research project, and they want to build a team of collaborators. Either by having repeatedly seen George and Annabel's names on facet reviews, or by conducting a specialized search on PiePlate, Tom and Henry invite the pair to join their team.[15]

## OTHER BENEFITS & INCENTIVES

The primary benefit of PiePlate is a central display of a paper's assessed review facets. A secondary benefit is the opportunity for readers to contribute micro-reviews on facets that either are not yet reviewed (or under-reviewed or "wrongly"-reviewed) which may correspond to that reader's particular expertise. In this section, I want to explore some potential tertiary benefits for the wider research community not discussed elsewhere in this paper. As a caveat, these *other* benefits may depend on the successful uptake by the research community of the first two benefits.

[15] This example uses four (Formal Analysis, Methodology, Funding acquisition, Conceptualization) of the 14 contributor roles on the CrediT Contributor Roles Taxonomy (casrai.org/credit).

Yarkoni (2012) said the "proliferation of metrics" clearly indicated the existence of a large market for "better measures of research performance," but decried the basis of these metrics on citation counts as a major shortcoming. In a next generation evaluation platform, Yarkoni (2012) described a move away from simple citation counts, toward more sophisticated quantitative metrics that could allow a user to customize settings to emphasize, for instance, "innovation and creativity over methodological rigor." In a scholarly system where PiePlate had achieved successful uptake, groups with research assessment duties could utilize APIs to manipulate facet data to do just as Yarkoni suggested.

Beyond evaluations, Yarkoni (2012) also discusses how next-gen platforms could allow journal editorial boards to use metrics to select preprints for publication, and how journalists could "preferentially weight novelty when selecting work to report on." PiePlate could be used to identify papers on a certain topic, from a specific time range, which have met a particular threshold of review, to facilitate semi-automated mega-overlay journals. Science reporters could utilize PiePlate similarly to report on cutting edge research, and additionally make clear to the reader what level of review the paper had undergone.

In both use cases, neither a journal editor or science journalist would have to consider all facet reviews equally. It may be that certain facets are more vital to have been assessed positively than others before reporting on them. Certain reviews, and thus reviewers, will become more apparently appreciated their constructiveness. Conversely, reviewers whose track record of positively assessing papers that become retracted (on the facet that reviewer assessed) would likely lose credibility over time, just as reviewers who are early to highlight important works[16] would gain credibility. The final question concerns how to recognize, reward, and incentivize researchers who may wish to make reviewing a larger or even primary share of their contributions to science.

Therefore, the final purpose of PiePlate we will discuss is using it for citing peer-reviews. Earlier in the paper, scenarios were described where i.) manuscripts not submitted to a journal could potentially undergo higher level of review than manuscripts which have been formally published, and ii.) where researchers could choose to cite a paper based on a completely different set of

[16] At rates higher than if they simply were highlighting every work they can claim "first" on.

peer-review assessments than those originally provided from a journal. And earlier in this section, it was described that iii.) science journalists could use PiePlate to make clear to the reader what level of review the paper had undergone in their reporting, and iv.) journals could use PiePlate to choose papers that meet certain review thresholds for publications. All four of these scenarios would be outcomes from a single functionality of PiePlate.

With PiePlate, researchers, reporters, and editors who wish to cite or link to a paper will be able to generate a doi (digital object identifier) *add-on*. This augmented doi includes the original doi at its base, plus an additional set of information that can be used to represent a paper's total state of review at the time of retrieval, or only a particular set of facets the user has selected. The doi add-on envisioned would operate similarly to URLs which have additional referral text. Below is a brief description of how these two options might potentially work in practice.

A **total state** PiePlate add-on doi captured on November 8, 2020 might appear like:

**[the doi address]/[referred from PiePlate][referring to all reviews captured on or before Nov. 8, 2020][created on Nov. 8, 2020]**

The bracketed information in the above URL structure describes the following.

the doi address: the doi of the paper in question

referred from PiePlate: describes that the following information refers to PiePlate data

referring to all reviews captured on or before Nov. 8, 2020: includes all facet reviews dated on or before this time

created on Nov. 8, 2020: *only includes facet reviews which were collected by PiePlate on or before this time, and reflects the state of those facet reviews as they appeared on or before this time (in order to reflect for scenarios in which data on earlier-conducted reviews were late to be collected by PiePlate; if reviews that appeared at the time have been removed after 11-08-2020; and if a rating system for reviews were implemented)

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A **selected facets** PiePlate doi add-on captured on November 8, 2020 might appear like:

**[the doi address]/[referred from PiePlate][referring to the following reviews]=[facet1&review1][facet4&review2&review3]**

The bracketed information in the above URL structure describes the following.

the doi address: the doi of the paper in question

referred from PiePlate: describes that the following information refers to PiePlate data

referring to the following reviews: describes that the following information refers to particular facet reviews

facet1&review1: describes the first recorded review on the first positioned facet

facet4&review2&review3: describes the second and third reviews on the fourth positioned facet

In this fashion, PiePlate can be used to augment a doi with information about a range or selection of facet reviews that correspond to the paper. Researchers, journalists, and editors may then choose to use a PiePlate-augmented doi in places they would have otherwise included a vanilla doi, such as a reference list, link in a story, or overlay journal. Users clicking on the augmented doi would be presented with both the paper and the facet reviews that were selected for inclusion. Readers then gain context about the reception the research community had given a paper at a specific moment in time, or the reception that a researcher, journalist, or editor had chosen to pay attention to. This model may also demonstrate how reputational effects for reviewers could be applied within the PiePlate system.

More important than any sort of imagined credit, badge, or digital karma that PiePlate could award to a peer-reviewer, the augmented doi function would facilitate a paradigm in which peer-reviewers receive *citations*. Just as the benefits of citations on a paper accrue for each of its contributors as well as for the publishing journal, benefits of citations on a paper should go toward select peer-reviewers who contributed meaningfully to a paper. The caveat to this expansion is that future reforms in related areas should apply to peer-reviewer citations. For instance, a peer-reviewer would not be considered an author, but a contributor whose role is assigned as a reviewer in a system like CRediT. The impact factor of the journal which published a paper that a peer-reviewer contributed toward would be de-emphasized, following SF DORA. And as citation sentiment technology progresses, it would be possible for a reviewer contribution to be cited in a contradictory or negative manner, not just in positive or neutral terms.

It has long been desired for researchers to be able to more quickly sort and filter for relevance and quality, with seemingly just two paths to achieve this goal. The first is by applying more sophisticated filters of assessment, both technological and human. The second is by incentivizing authors to write fewer papers.[17] As Yarkoni (2012) noted, “the ability to assign credit for contributions outside the traditional scope of scientific publication should incentivize

[17] Rather than attempting schemes to restrict authors to writing fewer papers.

contributions," especially from "trained scientists who work at teaching positions or in non-academic settings" that may "lack the time and resources to produce original research." We should expand Yarkoni's vision of an under-tapped peer-reviewer pool to include any trained researcher who wishes to contribute to scholarship and have heretofore chosen authorship as that route (rather than as reviewers) because that is the narrow way that contemporary science has chosen to define what counts as scholarship.

## CONCLUSION

It is an exciting time to observe different fields of research attempt to experiment with peer-review, each at their own pace and in their own formats, seeking to correct for what is not working and innovate for the future. PiePlate is a meta-scheme, proposing to collect and represent all forms of peer-review at a decoupled level, with benefits for every demographic that may use a research paper. The open knowledge community is encouraged to take the concept described here and build upon it freely, with attribution, for others to use freely as well.

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