"Aca 2.0 Q&A"
Usage scenarios and incentive systems for a distributed academic publication model

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Abstract

"Academia 2.0" is a proposal to organize scientific publishing around true peer-to-peer distributed dissemination channels and eliminate the traditional role of the academic publisher. This model will be first presented at the 2014 workshop on Rproducible Research Methodologies and New Publication Models in Computer Engineering (TRUST'14) in the form of a high-level overview, so as to stimulate discussion and gather feedback on its merits and feasibility. This report complements the 6-page introductory article presented at TRUST, by detailing the review processes, some use scenarios and answering the reviewer's comments in detail.

Contents

I fail to see how it is our job a scientists to keep publishers viable; in hindsight, no one believes we should've subsidised horse trainers and blacksmiths to compete with the rise of the automobile.

Merijn Verstraaten

Prologue

The present report is intended to be extended over time, as additional use cases, issues or opportunities are envisioned. Suggestions for improvements or new materials are welcome, and the contributor list can be adjusted accordingly. The latest version of this document, if any, can be retrieved from `http://arxiv.org/abs/1404.7753`.

1 Introduction

Supposing the publishing industry did not exist, what could we achieve to optimize scientific dissemination of knowledge and progress, short of recreating the publishing industry? This is what the "Academia 2.0" proposal [22] addresses.

The proposal can be summarized as follows:

- every researcher can self-publish online; including reviews of other works whenever they wish;
- works are securely timestamped and identified by title and author list and, where applicable, content hash;
- public organizations are responsible for publishing reviews that reviewers wish to keep anonymous while retaining accountability;
- a new semantic object, the "post-hoc citation" can be used to assert prior work, influence or plagiarism relationships when they are discovered only after publication;
- a new distributed infrastructure serves for document indexing and lookup; it also provides public and free interfaces for search and syndication, to aggregate and distribute, on-demand, relevant documents: per field of expertise, geographical area, social affinity, or relevance to a topic. See fig. 1

Following this proposal, a large number of questions have been raised by the TRUST review committee. The process of answering these questions also contributes to the elaboration of our model; a synthetic answer suitable for a summary would fail to convey the more nuanced aspects of our proposal.

For example, many questions have arisen regarding the organization of peer review: how to annotate works with measures of their appreciation by other members of the scientific community. For this, we elaborate a more complete structured answer in section 2.

In particular, the reviewers have highlighted that there have been already multiple efforts in the past to make the review process of scientific works more transparent. Our position is that the "Academia 2.0" proposal is *complementary*

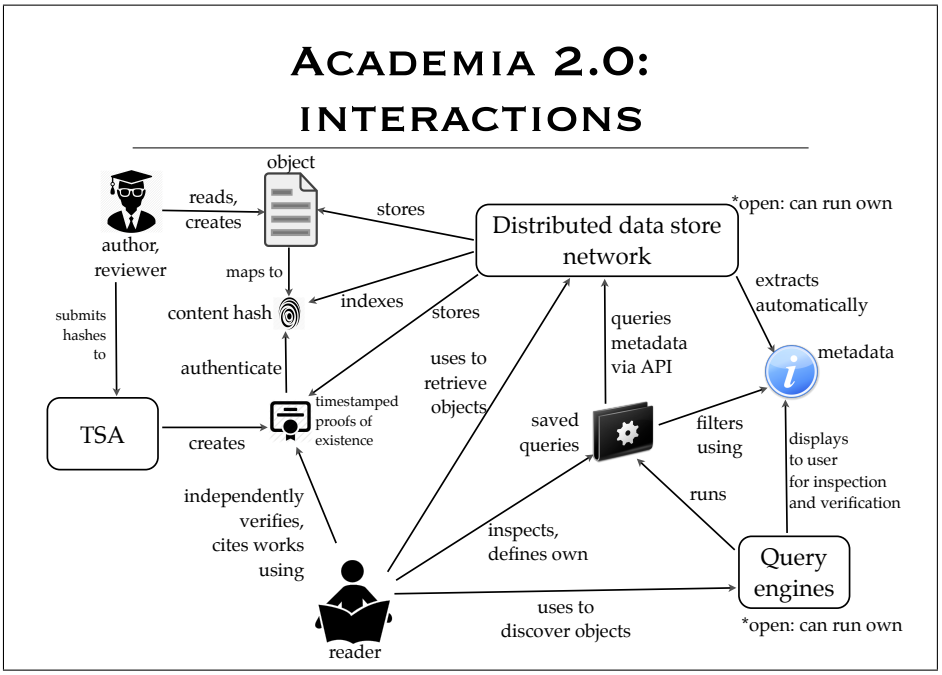

Figure 1: Overview of interactions in Academia 2.0.

to these previous efforts, by focusing on a different set of goals (cf. the first question in section 5 and section 2 of the TRUST article). Nevertheless, we also review the relationship between our work and contemporary efforts in open peer review below in section 2.5.

Similarly, the proposal enables a new incentive system, which in turn enables new scenarios for the way scientists interact with each other. We have highlighted two such scenarios in the TRUST submission; the reviewers have asked for more details and alternate scenarios, which we provide in section 3.

We then outline architectural aspects from a technical perspective in section 4, and address the remaining questions in section 5.

2 Peer review

The proposal promotes open peer review; we propose to explore alternative approaches where the review process is transparent, and/or where the text of reviews is public. If so desired, the identity of reviewers may be optionally hidden by an identity escrow service.

The basic "building block" is the review object: a document with semantic fields that identify separately the work(s) being reviewed by their document handles, the body of the review (text and/or grades), the author of the review, and which *review process* was used to produce the review object.

An example is given in table 1. This review object represents a possible encoding in our proposal of an actual review produced by the process of blind review of our submission to the TRUST workshop.

Table 1: Example review object: a TRUST'14 review

Author	"Anonymous reviewer 12 mandated by the TRUST'14 program committee"
Title	"Review of submission 1"
Target document handle	{ "Academia 2.0: removing the publisher middle-man while retaining impact", ["Raphael Poss", "Sebastian Altmeyer", "Mark Thompson", "Rob Jelier"], "sha256/e83b0a9861eec4906f52d269056925bd0692c77882ee54d0a62eb876cc61be69" }
Overall evaluation	2/3, higher is better
Reviewer's confidence	4/5, higher is better
Reviewer comments	The paper presents the idea to have an open publication model. The reviewing, indexing etc will be done in a crowd fashion using semantic technology. The paper is well written and presents novel ideas. My major concern for now is that the value of semantic technology is overestimated. It is also not clear how it can be made sure that not only too few reviews will be available and thus a wrong impression about the work is made visible.
Review process start date	2014-03-14
Review process end date	2014-04-14
Review process characteristics	• Author identity known to reviewer at start of process • Review committee known to author before start of process • Review object not released publicly before end of process • Reviewed object not released publicly before end of process
Review process coordinators	{ "Grigori Fursin" (INRIA, France), "Bruce Childers" (University of Pittsburgh, USA), "Alex K. Jones" (University of Pittsburgh, USA), "Daniel Mosse" (University of Pittsburgh, USA) }
Reviewer identity escrow	{ "Jose Nelson Amaral" (University of Alberta, Canada), "Calin Cascaval" (Qualcomm, USA), "Jack Davidson" (University of Virginia, USA), "Evelyn Duesterwald" (IBM, USA), "Lieven Eeckhout" (Ghent University, Belgium), "Eric Eide" (University of Utah, USA), "Sebastian Fischmeister" (University of Waterloo, Canada), "Michael Gerndt" (TU Munich, Germany), "Christophe Guillon" (STMicroelectronics, France), "Shriram Krishnamurthi" (Brown University, USA), "Hugh Leather" (University of Edinburgh, UK), "Anton Lokhmotov" (ARM, UK), "Mikel Lujan" (University of Manchester, UK), "David Padua" (University of Illinois at Urbana-Champaign, USA), "Christoph Reichenbach" (Johann-Wolfgang Goethe Universitat Frankfurt, Germany), "Arun Rodrigues" (Sandia National Laboratories, USA), "Reiji Suda" (University of Tokyo, Japan), "Sid Touati" (INRIA, France), "Jesper Larsson Traff" (Vienna University of Technology, Austria), "Petr Tuma" (Charles University, Czech Republic), "Jan Vitek" (Purdue University, USA), "Vladimir Voevodin" (Moscow State University, Russia), "Vittorio Zaccaria" (Politecnico di Milano, Italy), "Xiaoyun Zhu" (VMware, USA) }

(Note: this example reflects a real review)

As the example illustrates, review objects must be self-contained: the semantic data for evaluation scores embeds information on how to interpret the scores; the characteristics of the review process are embedded in the review object; the full list of individuals that serve as escrow for the identity of the reviewer is given explicitly, for accountability[1] Although not present in this example, we suggest also including contact information for the people involved, and optionally digital signatures to disambiguate homonyms.

Note that this entire review object is itself a publishable document, with a handle reusing its first two fields and a content hash of the entire object.

2.1 Characteristics of the review process

We propose to characterize review processes by the following properties:

- the start and end dates of the process, and who is coordinating;
- the point in time when the author identity is known to the reviewer(s). For example: "at the start of the review process" (open or simple blind reviews), "at the end of the review process" (traditional double blind review), "after a first version of the review object is released" (double blind review, PLDI-style);
- how the reviewer identity is known to the public. This can be either "open" (the reviewer publishes the review object under their own name), or "anonymized": the author field only lists a number or pseudonym, and an identity escrow (e.g. the program committee) is accountable for relating the review to an actual reviewer upon investigation if necessary (cf. section 2.2 below);
- when the reviewer identity is known to the public. For example: "prior to the start of the review process" (eg. conferences, where the program committee is published in the call for papers), "at the end of the review process" (eg. journals, where reviewers are selected only after works are submitted for review);
- when the review text is published. For example "immediately" (arbitrarily soon after the reviewer has finished populating the review object) or "at the end of the review process" (reviews held by a review committee until all reviewers have contributed, to guarantee reviewer independence).

"Academia 2.0" does not mandate a specific review process: whether the review is blind, double blind, open or otherwise. Instead, each review object should embed meta-information about the process that was used to produce it. Our example in table 1 illustrates use of a blind review process, although it is not named as such. The benefit of this *declarative* approach are threefold:

- it decouples the review object from the specific platform (in this case, Easychair for the TRUST workshop) that was used to coordinate the process, thereby ensuring the process can be understood and checked long after the specific platform has disappeared;
- it enables a more diverse set of review processes, while ensuring full transparency;

[1] In our example from table 1, the full program committee is listed as extrow. However, in some conferences/journals, only the chairs know the identity of reviewers. We believe this is not an issue, because in case of investigation the program committee will be able to redirect the investigation to the chair as needed.

Table 2: Characteristics of review processes

Author identity known to reviewer	Reviewer identity known		Review text availability		Reviewed work public	Found in...
	How	When	When	To whom		
Prior	Open	Immediate	Immediate	Public	Prior	Forums, blogs, survey articles, "related work" sections
Prior	Anonymized	Prior	Afterwards	Authors, PC	Afterwards, only beyond threshold	Traditional blind review (conference)
Prior	Anonymized, to authors only	Afterwards	Afterwards	Authors, PC	Afterwards, only beyond threshold	Traditional blind review (journal)
Afterwards	Anonymized	Prior	Afterwards	Authors, PC	Afterwards, only beyond threshold	Traditional double blind review (conference)
Afterwards	Anonymized, to authors only	Afterwards	Afterwards	Authors, PC	Afterwards, only beyond threshold	Traditional double blind review (journal)

Prior or afterwards	**Open or anonymized**	**Prior or afterwards**	**Immediate or afterwards**	**Public**	**Prior or afterwards**	**Academia 2.0**
Examples:						
Prior	Open	Prior	Immediate or afterwards	"	Prior	Author-requested review round on previous publication by author-selected reviewers
Prior	Open	Afterwards	Immediate	"	Prior	Spontaneous (reviewer-directed) review of an existing publication
Prior	Anonymized	Afterwards	Afterwards	"	Prior	Blind review round on existing publication by committee-selected reviewers
Afterwards	Open or anonymized	Afterwards	Afterwards	"	Afterwards	Double blind review round on new work by committee-selected reviewers

- the users of the review object can make their own opinion about the side effects of the review process (whether multiple reviews on the same work were independent, etc).

Naturally, this characterization is backward-compatible with the review processes already used in the existing ecosystem. We illustrate this in table 2.

2.2 Anonymous reviews

Showing the public identity of reviewers may impact the integrity of researchers: one may not be able to objectively and publicly criticize poor work performed by colleagues, or a potential future colleague in a hiring position.

To compensate for this, we suggest that public organizations (eg. conference program committees, libraries) propose *review anonymization* as an optional service to their local review contributors. Using this service, the reviews are public but published under a pseudonym, and the escrow is responsible for keeping track of real identities. This escrow service for researcher identities would also protect accountability: consistently poor reviews could then be tracked to their real authors after suitably authorized investigations.

How to deal with problematic reviews by anonymous reviewers? This would happen as follows: say, the public observes that a significant number of reviews coming from a single identity escrow are consistently poor. What to do about this?

At a first level, our model already enables the community to publish meta-reviews (reviews of the reviews) that denounce their quality, give them a poor

score, and thus influence transitively the ranking of the articles promoted/discredited by the poor reviews.

We also propose that escrow services provide an investigation board: if a petition of (external) researchers demands an investigation regarding a group of reviews, the escrow's investigation board should *internally* track the reviews to the anonymized review author (whom they know, as they are escrowing this person's identity) and request either the retraction of the reviews (by publication of counter-reviews by the same author) or a clarification/extension of the reviews. At no point is the anonymous author's identity disclosed to the external petitioners. If the escrow service is failing to respond to investigation requests, search queries could subsequently dismiss *any* review coming from the same escrow.

2.3 Organization of the review process

Open reviews are relatively simple in that they do not require any coordination: either an author contacts (a) reviewer(s) directly, or reviewer(s) decide spontaneously to perform a review, and review objects are published as soon as they are authored with all identities public.

Additional care is required for blind reviews, or review groups where multiple reviews are requested while providing some confidence the resulting reviews were authored independently from each other.

For conferences and next-generation journals (cf. section 3.4), this coordination could be performed as usual by the program committee, with the optional help of a technical review platform like Easychair.

Yet this coordination can also be self-organized directly by a group of authors and reviewers, using an *ad hoc* "review committee" selected for the occasion. For example, a self-coordinated blind review round could happen as follows:

- a group of authors prepares a work for publication, and generates document handles for them;
- the authors contact a group of experts in their field, to invite them for a review round with pre-determined start and end dates for the process;
- the authors mandate the experts who accept the invitation to, in turn, invite candidate reviewers (or decide to become reviewers themselves) but without revealing the reviewer's identities;
- the authors provide privately a copy of their work to the experts, together with a template for the review object containing the process meta-data; the experts then circulate the work and template (privately) to their selected reviewers;
- during the process (before the end date), the reviewers prepare reviews, and generate document handles for them;
- at the end of the review process, the reviewers release their review objects publicly and the authors release their work publicly.

Note that beyond the selection of reviewers, the experts selected by the authors need not be involved in the review process at all. The coordination of the process does not either require a centralized process management platform. In particular, the *review platforms become ephemeral*: one can deactivate/destroy the specific technical environment where reviews have been produced, without losing the reviews, their impact in query engines, and transparency about the review process.

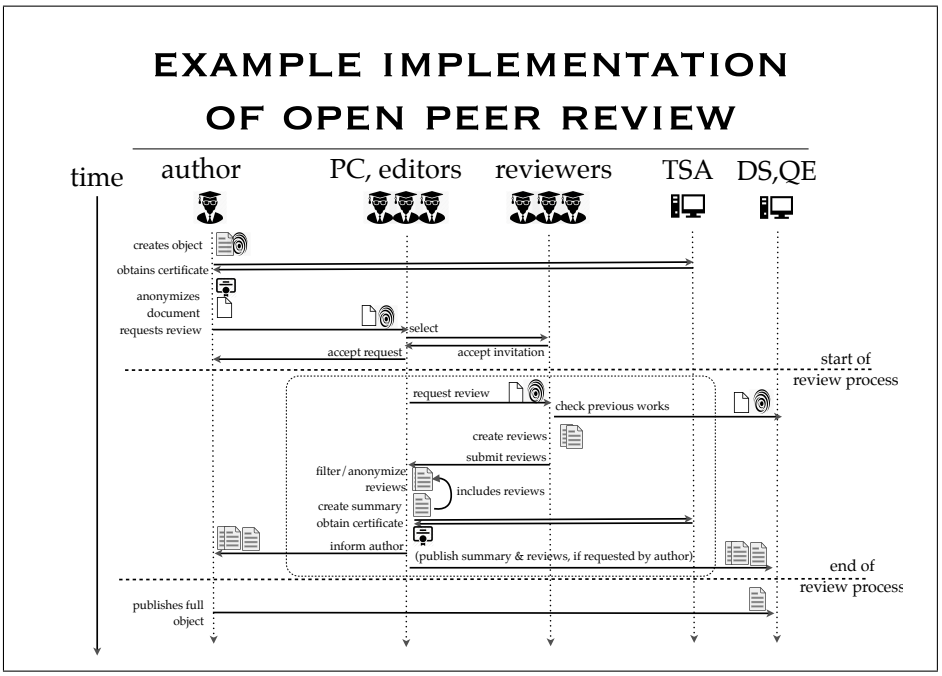

Figure 2: Construction of document handles.

2.4 Double blind reviews

Double blind reviews is an evaluation process where the authors submit their work in a way that cannot be traced back to them; and where the authors do not know who the reviewers are. After the review period, the identities of authors and reviewers for those works that have been "accepted" (evaluated beyond a predetermined threshold) may be released publicly.

2.4.1 Organization

It is possible in "Academia 2.0" to organize double-blind reviews, by extending the process from section 2.3 as follows:

- a group of authors prepares a work for publication that includes their names in the author list, and generates a content hash X for this non-anonymized version;
- the authors also prepare an anonymized version of the work;
- the authors organize the review round as in section 2.3, with the following adjustments: 1) the intermediate experts should not play the roles of reviewers themselves 2) the anonymized version of the work is provided for review 3) the review template includes the content hash X of the non-anonymized version;
- during the process (before the end date), the reviewers prepare reviews, including the content hash X, and generate document handles for them;
- at the end of the review process, the reviewers release their review objects publicly and the authors release the non-anonymized work publicly.

An example implementation is given in fig. 2.

Using the content hash of the non-anonymized version in the review object ensures that the review is securely linked to the work at the end of the review process, even though the reviewers do not know the author identities at the time of review.

2.4.2 Desirability of double blind peer review

Even though "Academia 2.0" enables double blind peer review, controversy exists in the scientific community as to whether it is at all desirable. Although this discussion falls slightly outside of the scope of this technical report, we include here an argument by D. Lemire [19] which summarizes the controversy:

> How well does it work in practice? You would expect double-blind reviewing to favor people from outside academia. Yet Blank reported [3] that the opposite is true: authors from outside academia have a lower acceptance rate under double-blind peer review. Moreover, Blank indicates that double-blind peer review is overall harsher. This is not a surprise: It is easier to pull the trigger when the enemy wears a mask.
>
> Meanwhile, there is at best a slight increase in the quality of the papers due to double-blind peer review [7]—everything else being equal. However, not everything is equal under double-blind peer review. What is the subtext? That somehow, the research paper is a standalone artifact, an anonymous, standardized piece of LEGO. That it should not be viewed as part of a stream of papers produced by an author. It sends a signal that an original research program is a bad idea. Researchers should be interchangeable. And to assess them, we might as well count the number of their papers—since these papers are standard artifacts anyhow.
>
> But that is counter-productive! Research papers are often only interesting when put in a greater context. It is only when you align a series of papers, often from the same authors, that you start seeing a story develop. Or not. Sometimes you only realize how poor someone's work is by collecting their papers and noticing that nothing much is happening: just more of the same.
>
> Researchers must make verifiable statements, but they should also try to be original and interesting. They should also be going somewhere. Research papers are not collection of facts, they represent a particular (hopefully correct) point of view. A researcher's point of view should evolve, and how it does is interesting. Yet it is a lot easier to understand a point of view when you are allowed to know openly who the authors are.
>
> Are there cliques and biases in science? Absolutely. But the best way to limit the biases is transparency, not more secrecy. Let the world know who rejected which paper and for what reasons.

Remarkably, "Academia 2.0" avoids a pitfall identified by M. Wilson [28], reported by D. Lemire:

> What if you pick up good ideas from double-blind papers that are later rejected and remain unpublished? How do you acknowledge the contribution of the authors of the unpublished work?

With our proposal, works reviewed by a double-blind process are still published even if the review scores are unfavorable. Post-hoc citations can then complement this by asserting influence relationships later on.

2.5 Previous work on open peer review

In 2011-2012, the journal Frontiers in Computational Neurosciences (FCN) ran a call to collect ideas and evaluations for alternate approaches to peer review in science. The resulting series of 18 articles on the topic, listed in table 3, was then linked together by one overview from Kriegeskorte et al. [17].

The "emerging consensus" [17] is a synthetic collection of *desirable features* that should be available in all new developments, and *feature choices* that will characterize different approaches from each other.

The features deemed universally desirable are:

- full transparency of the evaluation process;
- evaluative information is semantically encoded, eg. via priority scores;
- any group or individual can define a formula for prioritizing papers, fostering a plurality of evaluative perspectives;
- the evaluation process includes at least written reviews and numerical ratings;
- reviews and ratings are meta-evaluated (reviews of reviews);
- paper evaluations are weighted according to both the scientific and reviewing performance of participating scientists;
- the open evaluation process is perpetually ongoing;
- the new system can evolve from the current one.

Our proposed model matches all these expressed requirements. Note also that our model does not mandate a specific modality for the review process, and is therefore inclusive of all the proposals linked to by [17]. Different modalities could be exploited in different groups/places over time depending on each community's local requirements.

Some additional features are proposed in the article group but not deemed universally desirable by all authors in the group:

- whether the reviews are digitally signed;
- whether the author identities are securely authenticated;
- whether formal statistical inference is a primary feature of the evaluation process.

Our proposal is agnostic to these requirements. Beyond the basic proof of existence provided by our proposed secure timestamping, published objects can but do not have to include digital signatures for authors. As to which facilities are provided by query engines, our proposal welcomes implementations that are based on formal specifications.

Finally, the following feature choices appear polarizing in the group:

- whether evaluation begins with a closed, pre-publication stage, or whether all results are published continuously and *filtered* a posteriori;
- whether queries rank papers according to usage, social web information and citations.

Table 3: Articles on open peer review published in 2011-2012 in JCN.

Ref.	Author(s)	Title
[1]	T. Bachmann	Fair and open evaluation may call for temporarily hidden authorship, caution when counting the votes, and transparency of the full prepublication procedure
[2]	A. Birukou et al.	Alternatives to peer review: novel approaches for research evaluation
[8]	R.V. Florian	Aggregating post-publication peer reviews and ratings
[9]	S.S. Ghosh et al.	Learning from open source software projects to improve scientific review
[11]	J.K. Hartshorne et al.	Tracking replicability as a method of post-publication open evaluation
[12]	J. Hunter	Post-publication Peer Review: Opening up Scientific Conversation
[13]	G. Ietto-Gillies	The evaluation of research papers in the XXI century. The Open Peer Discussion system of the World Economics Association
[14]	D.J. Kravitz et al.	Toward a new model of scientific publishing: discussion and a proposal
[15]	G. Kreiman et al.	Nine criteria for a measure of scientific output
[16]	N. Kriegeskorte	Open evaluation (OE): A vision for entirely transparent post-publication peer review and rating for science.
[18]	C. Lee	Open Peer Review by a Selected-Papers Network
[21]	U. Pöschl	Multi-stage open peer review: scientific evaluation integrating the strengths of traditional peer review with the virtues of transparency and self-regulation
[24]	J. Priem et al.	Decoupling the scholarly journal
[25]	E. Sandewall	Maintaining Live Discussion in Two-Stage Open Peer Review
[26]	A. Walther et al.	FOSE: A framework for open science evaluation
[27]	J.M Wicherts et al.	Letting the daylight in: reviewing the reviewers and other ways to maximize transparency in science
[29]	J. Zimmermann et al.	Network-based statistics for a community driven transparent publication process

Here again **our proposal is agnostic**. A community of researchers may decide to self-organize and only publish works in our proposed data stores after they have received a predefined number of positive reviews from their community. But this is not mandatory. As to how queries are organized, our proposal distinctly specifies that any user of a query engine can specify their own queries, and we thus expect that a diversity of criteria will be exploited in practice. At any rate, each individual review object will contain meta-data as to which review process was used (cf. section 2.1), so that its characteristics stay visible over time and can be analyzed later on.

3 Scenarios and incentives

3.1 Fear of credit loss

(This scenario is already included in the TRUST overview article [22])
Some researchers have strong feelings against the mandatory publication of software, tools and dataset next to research results, arguing that this openness and transparency will enable competitor researchers to exploit said tools and then publish results earlier than the original author. When this happens, the first researcher has to bear the main cost of the research (time, effort) but cannot reap the profits (a lot of emphasis in reward systems is put on which researcher is first to publish), which is quite unfair indeed. This incentive to avoid publication hinges on both the reality of unscrupulous researchers, and the reality of the long publication time for journal articles (commonly up to one or two years between submission and final acceptance).

Obviously, our proposal eradicates the second factor as publication then becomes essentially instantaneous. As for unscrupulous researchers, our proposal has a number of built-in features which are relevant.

First, secure timestamping certificates can be obtained by a researcher on his or her preliminary results, *before they are actually available publicly*: our proposed time authorities can issue a timestamp based only on the hash of a document's content, so the actual content can remain private until a later date. This enables a researcher to operate using the following workflow:

1. prepare the tools;
2. compute some preliminary / proof-of-concept results using them;
3. privately obtain a timestamp certificate, which attests the work's existence although it is not published yet;
4. publish the tools;
5. later, when more results are obtained, publish the high-level outcomes of the research.

Using this process, if a competitor exploits the published materials from step #4 and claims original work similar to #3, the first researcher can assert his or a her prior work *a posteriori* using the timestamp certificate.

Moreover, supposing the original researcher did not realize that further results have been published by competitors without attribution or failed to request timestamp certificates early, the post-hoc citation mechanism can be used as well: the research or even a peer can publish a statement of influence, from the "real" original work to the competitor work, after both have been published and *regardless of publication order*. In practice:

1. some work is discovered to be likely "heavily inspired" on some other work;
2. one or more researchers publish post-hoc citations declaring the same;
3. the social network of the interested parties scrutinizes the relationship and, when deemed relevant, strengthen the weight of the post-hoc citations in the search network by adding *positive reviews* for the post-hoc citations themselves.

Using these steps, both original and derived work become linked by the post-hoc citations. Agreement by peers strengthen the post-hoc citations. To fully exploit this opportunity, we envision that query engines list both sides of post-hoc citations when a search query would otherwise only return one side, together with the relevant context (including comments) around post-hoc citations.

3.2 Early publication

What motivates a contributor to (self-)publish their work early? What are reasons this might be undesirable?

Pros: faster dissemination & more reuse. This is especially relevant in technology fields where know-how can become obsolete within 1-2 years. Factoring both communication, evaluation and learning times, a publication pipeline longer than 1-2 months may make reuse less attractive than redesigning from scratch.

Cons:

- the earlier a work is published, the less scrutiny it receives *prior* to publication. This may result in an average quality decrease. **Solution:** *continuous evaluation* post-publication, and adequate *post-publication filtering* based on the current network of reviews and reuse links.
- each individual publication from an author/group may reflect a smaller incremental step since a previous publication. This may result in increasing volume of literature for the same research output. More volume in turn makes dissemination more difficult (other researchers have a limited "reading bandwidth"). **Solution:** develop an authoring culture where *works become distributed*: each publication could be split in a 1-2 pages *overview article* with motivation and conclusions, with *links to separate published objects* for results, methods, tools and analysis. If this happens, the throughput of overview articles may increase, (which is desirable), but without overloading the reading time of research peers too much.

3.3 File drawer effect and publication bias

What motivates a contributor to avoid (self-)publishing negative results? How to promote/ease/favor the public availability of negative results? How to prevent publishers from refusing to publish negative results?

Proposed approach: ideally, any work on an experiment could be packaged as publishable objects for intent, methodology, and result sets over time. The distributed nature of "Academia 2.0" implies that researchers can obtain secure future-proof identifiers for any object virtually for free (a proof of existence

only requires a digital signature of the author list, title and content hash, not the content itself), so the gathering of identifiers could be fully automated in experimental workflows, and the negative datasets can be kept stored at the location where they were initially produced. Negative results can then be cited and reused from the same researchers or their peers.

This workflow avoids distribution costs (negative datasets left at site of production), reviewing costs (no external party involved), and registration costs (proof of existence based merely on content hash), while ensuring that negative results are available for reuse shortly after they are produced.

3.4 Next-generation journals

In the current ecosystem, journals provide multiple services:

1. they centralize document storage;
2. they organize dissemination of documents (publicity and access);
3. they coordinate the review process;
4. they provide an entry point for research communities to quickly identify "top publications" in their field.

Journal publishers currently charge high fees, claiming these fees are needed to cover the costs of services #1-#3, and these fees are tolerated by the research community because they are currently the most efficient provider of service #4.

As explained previously [22], "Academia 2.0" mainly intends to replace publishers for services #1-#3, and drive down the associated costs. The proposal also suggests implementing service #4 using saved queries and syndication, thereby replacing journal publishers entirely.

However, note that *removing the role of publisher does not imply that the concept of journal disappears.* Instead, "Academia 2.0" enables **next-generation journals**, with lower operating costs and new revenue streams.

3.4.1 Organization of next-generation journals

A next-generation journal would be identified by:

- a group of owners, replacing the role of "steering committee" or "editor";
- a site location on the Internet, under control of the owners, which advertises itself as "a journal";
- a set of portal web pages on that site that automatically display the results of searches from pre-saved queries;
- the definition of the pre-saved queries, created/configured by the owners to automatically select the published objects that match the journal's criteria; *these must be kept public* so that users can assess the journal's criteria and determine how it chooses to influences the scientific field;
- *added-value services* that the owners can charge for.

The process to create such a journal is simple, and can be thus instantiated at near-zero cost by any scholarly organization for more fluid competition:

1. a group of experts self-organizes and appoints itself as a new journal owner;
2. they set up a query engine using the standard "Academia 2.0" software on their own hosting location;
3. they define their own pre-saved queries according to their desired criteria;
4. they set up a web site / portal to present query results;
5. if desired, they set up extra added-value (chargeable) services.

From then on, the journal can run "hands off", optionally entirely independently from the review process(es) (cf. section 2).

3.4.2 Revenue stream

This model of next-generation journals prevents journal owners from charging for the mere distribution and access to the works, since the queries are public and can thus be arbitrarily reproduced by third parties.

Instead, revenue can be extracted using added value services, for example:

- guaranteed low-latency access to all linked documents/objects (a document cache);
- moderated online discussion fora for (group of) selected works;
- match-making services, to put researchers in contact to other individuals with similar interests in their field;
- opt-in advertisement services to the press or other organizations.

4 Matters of architecture and implementation

In short, "Academia 2.0" proposes to combine:

- a new *culture* for scholars, which encompasses open peer review and decentralized storage and filtering;
- a new *incentive system* which makes low-cost global and long-term access to knowledge possible, while enabling new business forms;
- a set of *feature requirements* for platforms that are compatible with the "Academia 2.0" vision;
- a federation of *platforms* that satisfy the rquirements and provide the model's components: time stamping, data stores and query engines.

4.1 Current status

Regarding culture, the growing discontentment of scholars with the existing publishing ecosystem, and the numerous initiatives to develop open access and open review, was already pushing the "Academia 2.0" agenda before this proposal was written. The present proposal complements this cultural shift by connecting it with concrete proposals for a tool-workflow integration and specific requirements to satisfy the simultaneous goal of guaranteed cheap and long-term access.

The incentive system is being developed iteratively; some first steps are visible already in sections 2 and 3 in this document.

The rest of this section 4 outlines the feature requirements.

As to platforms, the "Academia 2.0" proposal does not mandate a specific implementation. It is likely that we (the proposal's authors) will propose an example implementation, for the sake of illustration; meanwhile, we also acknowledge multiple projects around the world that develop tools already compatible with the "Academia 2.0" vision, including in particular:

- the Public Knowledge Project (PKP, `https://pkp.sfu.ca/`) in Canada, which produces open source software platforms for online journals, monograph publication, conference organization (incl. publication of proceedings) and metadata indexing and search;

- Cornell University Library's arXiv (`http://arxiv.org/`), which provides an online service for document registration (time stamping) and long-term storage.

The PKP's "Harvester system", for example, could be seen as a suitable implementation of an Academia 2.0 data store and query engine, able to import documents from any OAI-compliant archive. The arXiv repository can be combined with an index of content hashes to become a suitable Academia 2.0 data store.

Additional platforms dedicated to organizing conferences or online journals, for example those provided by the PKP, are *complementary* to the "Academia 2.0" vision and could be extended to connect to its data stores and query engines.

4.2 Secure timestamping

The distributed data stores must annotate incoming documents with proofs of existence, that attest they existed at the time they were submitted. We are interested in time stamping schemes that can be verified by third parties long after they were generated, and that do not require to trust one arbitrary party.

There exist multiple open standards and technologies to do this, including RFC 3161 & 4998, ANSI X9.95 and ISO 18014 (see list below). Each standard defines how to *package* and distribute time stamps, and supports multiple different mechanisms to *generate* them, acknowleging that different applications have different security goals.

For example, with PKI-based generation mechanisms the authentication is dependent on the trust user place on the owners of private keys to use them properly and keep them secret.

Another example is linking-based generation mechanisms. There a combined ("linked") hash is published, at fixed time intervals, of the documents created since the last publication. This is done for example via newspapers. The authentication is then dependent on the trust users place on the wide distribution of a newspaper and archival of previous issues.

For "Academia 2.0", we propose to define platforms that support multiple timestamping protocols, including at least some common existing mechanisms (e.g. arXiv's version identifiers) and at least one linking-based generation mechanism, with chains of document hashes authenticated and archived over time by universities.

Related academic references:

- [10] Haber et al. "How to time-stamp a digital document", 1991.
- [4] Blibech et al. "A New Timestamping Scheme Based on Skip Lists", 2006.
- [5] Buchmann et al. "Hash-based Digital Signature Schemes", 2009.

Current open standards and specifications:

- RFC 3161, "Internet X.509 Public Key Infrastructure Time-Stamp Protocol (TSP)". Abstract: *This document describes the format of a request sent to a Time Stamping Authority (TSA) and of the response that is returned. It also establishes several security-relevant requirements for TSA operation, with regards to processing requests to generate responses.*

- RFC 3628, "Policy Requirements for Time-Stamping Authorities (TSAs)". Abstract: *This document defines requirements for a baseline time-stamp policy for Time-Stamping Authorities (TSAs) issuing time-stamp tokens, supported by public key certificates, with an accuracy of one second or better. A TSA may define its own policy which enhances the policy defined in this document. Such a policy shall incorporate or further constrain the requirements identified in this document.*
- ANSI X9.95, "Trusted Time Stamp Management and Security". Abstract: *This standard specifies the minimum security requirements for the effective use of time stamps in a financial services environment.*
- RFC 4998, "Evidence record syntax". Abstract: *In many scenarios, users must be able prove the existence and integrity of data, including digitally signed data, in a common and reproducible way over a long and possibly undetermined period of time. This document specifies the syntax and processing of an Evidence Record, a structure designed to support long-term non- repudiation of existence of data.*
- ISO/IEC 18014, "Information technology – Security techniques – Time-stamping services". Abstract: *ISO/IEC 18014 specifies time-stamping techniques. It consists of three parts, which include the general notion, models for a time-stamping service, data structures, and protocols.*
- OpenKSI, "Open working group for keyless signature infrastructure". Abstract: *Keyless Signature Infrastructure (KSI) is a web-scale digital signature/timestamp system for electronic data. The term 'keyless' denotes that the signatures can be reliably verified without assuming secrecy of cryptographic keys. Keyless signatures are not vulnerable to key compromise implying that their lifetime is based only on the security properties of the cryptographic hash function and also that their security properties will survive intact when practical quantum computing becomes a reality.*

4.3 Document handles

"Academia 2.0" is strongly defined by content-based addressing: works and documents are identified by their content; not by where they are stored (file name, database record identifier), nor where they were published (publication name, date, page number). This enables long-term persistence of documents, robust to changes in organization names, technology evolution, economical situations, etc.

The most prominent feature of "Academia 2.0" which advertises content-based addressing to users is the *document handle*: a 4-tuple consisting of the work title, author list, content hash and secure timestamp. See fig. 3. The "hash" part of a document handle is also the key that refers to the data of the work identified by the handle: *data stores* accept request for such a key, and return a copy of the data as response. The timestamp is a proof of existence of the data linked to by the hash, not of the document handle itself.

Note that only the content hash and timestamp should ultimately be authoritative: the work's title and author list should be present in the document itself (and thus captured by the hash and timestamp), and the information only copied in the handle to ease indexing by data stores. When possible, an implementation can even extract the title and author list on demand from the document's contents. This makes it also possible to keep document handles

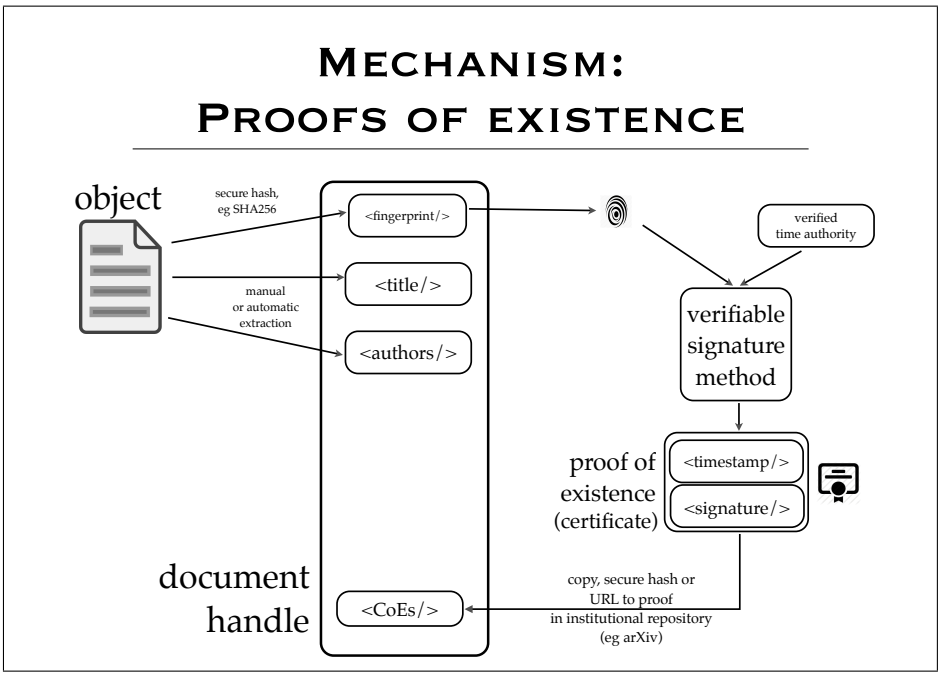

Figure 3: Construction of document handles.

short when the title spans multiple lines (or sub-titles are present) or the author list is particularly long (in some fields, scientific articles have hundreds of authors).

For example, a document handle for version 2 of the present report could be:

Field	Value
Title	Aca 2.0 Q&A
Authors	"R. Poss", "S. Altmeyer", "M. Thompson", "R. Jelier"
Fingerprint	`bt:SCKLR5FUBXJ5FVZCKVDR2CHJ2Y7EPSFK`
CoEs	`arxiv:2014-05-10:1404.7753v2`

In this handle:

- the fingerprint identifies the PDF document (cf. next section, and also [23]);
- the title field contains a reduced version of the full title of the document, which further extends to "Usage scenarios and incentive systems for a distributed academic publication model";
- the author list omits the full first name of each author;
- the timestamp uses arXiv's authority to assert that the document was visible on May 10th, 2014, with arXiv's document identifier as signature.

4.4 Object model

With "Academia 2.0" we wish to promote structured data, so as to support also collections of items (e.g. data sets) or academic articles with separate data streams for print (e.g. PDF) and web display (e.g. HTML).

We thus propose to develop an *object model* which supports both singleton

files and collections. A possible implementation could be inspired by the Git object model [6, 20]. Our technical proposal in [23] follows this suggestion.

4.5 Object storage and distribution

The high-level view of "Academia 2.0" is that data stores are responsible for the persistence of objects over time, maintain metadata and reply to object queries from users and query engines.

To realize this, we need to reconcile two apparently conflicting requirements. On the one hand, users value the authority and seriousness of official institutions such as university libraries, and will trust them more to persist data in the long term. On the other hand, users wish unrestricted access to content over the entire network, but official institutions will likely regulate access in accordance to affiliation and local licensing rules.

4.5.1 Suggestion: a dual network

Our proposed approach is to set up different networks of data stores simultaneoulsy, with different objectives and policies but using a common interface (API) to users and query engines. We propose to begin with the following combination:

- an *institutional network* of data stores, where each node is managed by a public organization. This network may:
  - restrict the point of submission from authors by affiliation or geographical proximity,
  - maintain explicit and contractual peering agreements between data stores,
  - attribute one or more "home" data store to each object, in order to attribute the responsibility for long-term storage of an object to the organization(s) hosting its "home" data store(s);
  - delete "old" copies of objects stored in other stores than their home locations;
  - propagate unsatisfied object requests from users or query engines along peering links until either the object is found or a strong confidence is ascertained that the object does not exist in the entire network.
  - propose "quality control" on submissions, or license-based access control to non-public objects.
- a *peer-to-peer network* of data stores, where each node is managed by an individual person. This network may:
  - refuse external submissions for new objects altogether (only each node owner can insert objects locally, for example their own documents);
  - maintain loose peer-to-peer connections with other data stores;
  - implement object queries using a distributed hash table (DHT) protocol;
  - keep transient cached copies of objects gathered by queries, so they become candidates to further searches.

In short, we propose that "Academia 2.0" relies simultaneously on a network of conventional document repositories with institutional control over object distribution, and a Bittorrent-like peer-to-peer file sharing network where

distribution is under personal responsibility of its node owners.

The institutional network would be fast to answer queries, more certain about unsatisfied queries ("no answer = the object does not exist"), guarantee long-term storage institutionally, but may limit free access to objects; whereas the peer-to-peer network would be slower to answer queries, less certain about unsatisfied queries ("no answer = the object may or may not exist"), dilute/distribute responsibility for long-term storage, but will guarantee free access to objects.

4.5.2 Side benefits of the dual approach

Our proposal to use a dual design was also intended to solve a major challenge of "Academia 2.0": how to deploy the new model side-by-side with the existing publishing ecosystem.

In particular, to promote the use of our query engines, it is relatively important that data stores index and generate metadata for a large corpus of historical published works, *including those held exclusively by existing publishers.* In other words: since existing publishers disallow redistribution of their content outside of their distribution channels, how can their works become visible in Academia 2.0?

Certainly, a proposal to include publisher-protected articles in the institutional network would imply that the participating institutions pay a licensing fee to the publishers. The related financial, logistical and political issues would likely create friction to a speedy migration to the new model.

This is where the peer-to-peer network would ease the transition, by exploiting a particular feature of the legal system around academic publishing: both authors and customers that have already paid once to receive a copy of a work are allowed to distribute copies to an audience of students or other peers that contact them directly. In other words, publishers have already long agreed that direct peer-to-peer distribution of scholarly content is acceptable as long as the source of documents is properly linked to an author or licensed user.

This is a major difference between the rights given by publishers to scholarly authors and licensed users, and the rights given by film and music publishers to artists and consumers: neither artists or consumers receive a license for private redistribution. This is why peer-to-peer redistribution of works in Academia 2.0 can be built-in from the get-go, without concern for licensing conflicts.

In practice, the scenario would be covered as follows:

- both the institutional and peer-to-peer network would "know" about previous documents, identified by their content hash; both would import metadata from either personal repositories from scholars, or from their library collections;
- however, the institutional network would only know about the existence of the documents, and not store a copy of the objects identified by the metadata;
- a user wishing to consult a previously published work would then have a choice between:
  - either contacting the legacy publisher directly to obtain a license for the content; or
  - query the peer-to-peer network for the content hash and receive a copy of the content directly from a source willing to share it.

To ease the transition, it may be possible to identify nodes in the peer-to-peer network by the identity of their owners, so as to establish a clear audit trail for document copies. This full transparency of content propagation will probably make the transition smoother for the existing publishers.

5 Questions and Answers

Q: What exactly are the goals of the new model?
A: The goal is to *optimize dissemination*, with three sub-goals: 1) make dissemination faster 2) promote open peer review 3) make dissemination as cheap as the propagation of free speech in society and 4) guarantee persistence and availability of content over time.

We acknowledge that previous work already exists to address #1 and #2, however we believe that our proposal is the first that proposes a concrete framework that addresses all 4 goals coherently.

Q: What exactly are the "negative incentives to publication" (Section 6) that are addressed in the paper?
A: We really mean "incentives to not publish." We are focusing here on the publisher-created culture which only acknowledges the existence of scientific works once they appear on the publisher's document listings. Because of this culture, authors refrain from publishing (= making their work publicly available) before the publisher-mandated publication process completes, because otherwise other unscrupulous authors could reuse the work, advance their research faster and publish the results under their own name. This problem is avoided by providing near-instantaneous secure authentication of document existence, which authors can use immediately after completing their work and before they receive reviews from peers.

Q: The ACM digital library already support comments on papers. Why is this not used more?
A: Because such comments are "held" by the ACM, who can decide to remove/-modify/hide them arbitrarily at any time. These comments also do not increase the visibility and reputation of the reviewer. We propose to treat reviews as publications, which generates an incentive to write reviews in the first place.

Q: who is in a position to spots conflicts of interests between anonymized publications and anonymized reviewers?
A: Who is in this position now? The academic publishers have already given the responsibility to spot and resolve conflicts to the program chairs and/or journal editors; esteemed members of the research community that are in charge now and would remain so in our model.

Q: "we suggest that universities propose *review anonymization* as an optional service to their local research staff. Using this service, the reviews are public but published under a pseudonym, and the library is responsible for keeping track of real identities. This escrow service for researcher identities would also protect accountability: consistently poor reviews could then be tracked to their real authors after suitably authorized investigations." **Authorized by whom?**

See section 2.2.

Q: How does the proposed model compare to similar, previous proposals for open peer review?
A: Previous proposals for open peer review have focused on the quality of research evaluation, and the transparency of the review process. Our proposal embraces these goals, but focuses on a different aspect: cheap dissemination and persistence of content over time. Our proposal and previous work on open peer review are thus complementary to each other (cf. section 2.5).

Q: how to ensure the quality of the formatting, typography, language etc?
A: To answer this we must consider separately language, and formatting/typography. For formatting/typography, we expect each community to settle on a set of standard document templates. Again we capitalize on a recent development: since the turn of the century, most authors have learned to use templates for formatting and typography and are able to produce print-ready PDF documents of their manuscripts. This is particularly true of mathematics, logic and computer science, but our experience shows the same results can be obtained in most other scientific fields.

For language, a large majority of articles are typically corrected prior to submission already; most conference articles for instance are of sufficient linguistic quality despite the lack of external editing. When in doubt, or in regions where documents are published in a language where most local practitioners are not proficient, a free market of proofreading services would develop, in extension to the services already available for publishing academic theses. These services are typically much cheaper per article than the price charged by publishers for publication/access.

Q: What would motivate a researcher to do a review of another work?
A: Foremost reputation and visibility, but also the intention to inform a fellow researcher about the quality/correctness and usefulness of a paper. As reviews are considered publications, writing a review can increase one's reputation.

Q: Who would 'force' the researcher to actually do a review?
A: Researchers are currently not "forced" to do reviews by journals or conference organizers, and our proposed model does not force reviewers either. However the transparency of reviews will become an incentive to participate. See the previous question.

Q: What could be a minimum viable prototype of this publication model to get people started?
A: We have answered this already partially in the TRUST article: the minimum is a working proof-of-existence authenticator, a lookup service from document handles to document contents, and one or more query engines. We estimate that the effort to reach a prototype is less than a man-year effort by a computer engineering graduate with a specialization in software engineering and distributed systems.

Q: Does Academia 2.0 require changes to the current promotion and tenure system? What are those changes? Are such changes feasible?
A: We do not foresee any particular changes. Our proposal implies that communities of reviewers will form, with their own saved queries (all papers reviewed by members of our community) and viewing portals (cf. e.g. section 3.4). Consensus will emerge as to which communities are particularly good at spotting relevant work in their field, and membership to these communities can then be used for tenure evaluation.

Q: How long does it take for the "cream to rise to the top"?
A: Assuming this question relates to the duration between the point in time where a document becomes visible on the network, and the point where it starts to appear in search results: it will depend on the propagation of document copies between data stores, and the synchronization rate of document caches throughout the network. Once a document becomes accessible by a query engine, it becomes immediately candidate for search results; the time for it to reach the "top" of a search result list is then dependent on the rate of publication of positive reviews. Assuming an author of a newly published work does due diligence and announces their work to their community of peers through conventional channels (mailing lists, public announcements), reviews could start flowing in within a few days to a few weeks.

Q: About preservation of content: **Relying on author pages seems dicey. I am also not convinced that all institutions will be so concerned about preservation of material (sure, major libraries at major research institution will, but what about the lone researcher at a small teaching university?)**
A: Data stores would accept external submissions, in the same way as already done for Cornell University's arXiv service. See also section 4.5.

Q: How would double blind reviews work?
A: Double blind reviews would be organized by self-appointed committees, with a similar process as already used today in conferences and existing journals. See section 2.4.

Q: a hallmark of the journal review process is the mediated interaction between authors and reviewers. How does this work in Academia 2.0?
A: This is organized by workflows, in similar ways as currently organized. See section 2.

Q: I disagree that computer engineering is the scientific field that has the most potential to try out and evaluate the model. I think fields such as psychology, sociology, and physics are more likely to try out the model.
A: During an initial development phase, the tools may not be very user-friendly. In our view, practitioners in computer engineering will be more accepting of imperfections and more willing to contribute improvements the (open source) tools as needed. Of course, it may well be that other fields could also *use* the initial tools early simultaneously with computer engineering.

Q: should reviewer comments be published in full?
A: This largely depends on what queries the scientific community will deem useful to search, filter, rank and qualify works in query engines.

The key question is: what are the meaningful fields of a review object that are relevant to searching, filtering, ranking and qualifying scientific work long after the work was published and the review was authored?

With only numerical "evaluation grades", the meaning of these grades may be forgotten over time, lest a semantic model is provided alongside with the reviews to interpret the grades. Worse, grades do not convey the subtleties often intended by reviewers. By publishing "plain text" comments from reviewers, and assuming computers get better in analyzing semantics from human languages, richer and more meaningful query engines can be developed.

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