A concrete proposal for an automatically refereed scholarly electronic journal

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Abstract

A new kind of a not refereed electronic scholarly journal is proposed. Each paper is immediately published after its submission, but it is latter judged by the readers of the journal, leading to a dynamically updated score that measures the quality of the paper. The author of the paper has a score too, that is affected by the score assumed by his paper(s). Also the readers have a score, measuring the quality of the scores that they have assigned.

While time goes on, readers read the papers, judgments are expressed, and the corresponding scores vary consequently. The score of a paper can be used for deciding to read or not to read that paper; the score of authors and readers are a measure of their research productivity, then they will try to do their best for keeping their score at a high level, hopefully leading to a virtuous circle (publishing good papers and giving correct judgments to the read papers).

To demonstrate the feasibility of the system and its effectiveness, a possible realization of the journal is formally described through some mathematical formulae, and some small simulations of typical cases are presented.

1 Introduction

The communication mechanism that modern science still adopts nowadays arose in the 17th Century, with the publication of the first scientific journals, reporting in paper form the ideas, discoveries, inventions, of a researcher. Nowadays, since about 1930, the dissemination of scholarly information is based on *peer review*: the researcher that wants to disseminate her work writes a paper and submits it to a scholarly journal; the paper is not immediately published, but it is judged by some *referees*; if they judge it adequate, the paper is published.

The peer review mechanism is usually retained an adequate solution, even if not the ideal one: sometimes, the reviewing process takes too long, even one or two years, so that the published paper describes something old; sometimes the reviewers do not do a good job, accepting a bad paper or not accepting a good one, that after two years cannot be resubmitted because too obsolete; and so on.

Internet has changed, and is changing, this situation [1, 8]. The terms *digital libraries*, *on line books*, and *electronic journals* are used always more often [6]. Now a peer reviewed journal can be distributed by electronic means, and even the refereeing process can take place completely electronically, drastically reducing time and money for publishing: see for instance JHEP (http://jhep.sissa.it) or Earth Interactions [4] (http://EarthInteractions.org/). Multimediality can lead to a more effective communication [4]. Of course, there are also some drawbacks of electronic journals (copyright problems, legal validity, accessibility, and so on), and they seem to have not a large impact by now [3]; but the general feeling is that this is a temporary situation, and we just have to wait some years for overcoming these temporary problems.

The peer review mechanism has been criticized in the past, and Internet growth seems to amplify these critiques: many researcher maintain that Internet would allow a more fast, elastic, interactive, and effective model of publishing. For instance, Nadasdy [7] suggest to eliminate the peer review with democracy: each submitted paper is immediately published and the readers will judge it. Of course, the problem with this approach is that readers may not be capable of correctly judging the paper: whereas the referees are chosen among the experts of the field, everybody can read and judge a paper published on Internet. Harnad [2] says that "peer commentary is a superb supplement to peer review, but it is certainly no substitute for it".

In this paper, a new kind of electronic scholarly journal is proposed, with the aim of changing the submission-review-publication process. I try to make a step further on the road suggested by the not refereed journals just mentioned, and to present a mechanism that avoids some of the previously described problems.

The basic idea is the following (with some simplifications, as it will be clear in the last section). Each paper is immediately published after its submission, without a refereeing process; each paper has a score, measuring its quality. This score is initially assigned on the basis of the goodness of paper author(s), and later dynamically updated on the basis of the readers' judgments. A subscriber of the journal is an author or a reader (or both). Each subscriber has a score, initially assigned on the basis of the editorial politics of the journal (it could be the average of all subscribers, or a predefined constant score, or something else), and later updated on the basis of the activity of the subscriber. Therefore, this score is dynamic too, and changes in order to have a consistent status: if an author with a low score publishes a very good paper (*i.e.,* a paper judged very positively by the readers), her score increases; if a reader expresses an inadequate judgment on a paper, her score decreases accordingly, and so on.

While time goes on, readers read the papers, judgments are expressed, and the corresponding scores vary consequently. The score of a paper can be used for deciding to read or not to read that paper; the score of authors and readers are a measure of their research productivity, then they will try to do their best for keeping their score at a high level, hopefully leading to a virtuous circle (publishing good papers and giving correct judgments to the read papers).

The paper is structured as follows. In Section 2 a general description of the journal is presented. Section 3 introduces the notation that will be used in the following. Sections 4–8 describe in a precise way (through some mathematical formulae) how the updating of the various scores takes place. Section 9 presents some examples of typical cases, and Sections 10 concludes the paper and sketches some future developments.

2 General description

For understanding the details of the automatically refereed journal proposed here, let's follow the events happening while a paper is written, submitted, published, and read. The paper has an initial score, inherited from the score of its author (for the sake of simplicity, let's assume that each paper has one author only). The paper is later read and judged by readers. When a paper is read and judged, the following five steps are executed:

1. The paper score is updated: if the judgment is lower (higher) than the actual paper score, the paper score decreases (increases). Also the score of the reader has to be taken into account: higher rated readers' judgments will be more important (will lead to higher changes) than lower rated ones.

2. The author's score is updated: when the score of a paper written by an author decreases (increases), the score of the author decreases (increases). Thus, authors' scores are linked to the scores of their papers.

3. The reader's score is updated: if one reader's judgment about a document is "wrong" (too far from the average), the reader's score has to decrease. Then, the reader's score is updated depending on the goodness of her judgment (how much adequate her judgment is, or how much it agrees with the new score of the paper).

4. The score of the readers that previously read the same paper are updated: if a judgment causes a change in a paper score, the goodness of the previously expressed judgments has to be re-estimated. Then, a judgment on a certain paper leads to an updating of the scores of all the previous readers of that paper.

5. The steadiness values of the scores are updated: every object with a score (author, reader, and paper) has a *steadiness* value too. This indicates how much steady the score is: for instance, old papers will have a high steadiness, new readers (authors) will have a low steadiness. Steadiness affects the score update: a low (high) steadiness allows quicker (more slow) changes of the corresponding score. A steadiness value increases as the corresponding score changes.

To define in a precise way the behavior of the whole system, I propose in the following some formulae that formally specify how to compute the new values of the scores and steadiness of reader, paper, author, and previous readers. The formulae are one of the possible choices and are chosen mainly for simplicity (after a limited experimental activity), but will demonstrate the feasibility of the journal. More sophisticated solutions can be proposed and validated with an experimental activity.

3 Notation

I will indicate with:

- $s_r(t), s_p(t), s_a(t)$ the score of a reader, a paper, and an author, respectively, at time t. I will sometimes omit the time indication when this does not rise ambiguity.
- $\sigma_r(t), \sigma_p(t), \sigma_a(t)$ the steadiness of a reader, a paper, and an author, respectively, at time t.

All the score values are in the range $[0, 1]$ (0 is the minimum and 1 the maximum); all the steadiness values are in the range $]0, 1[$.

The scores updating take place in similar ways, though with different parameters, for all the above values. The general approach is that if j is the new judgment and s the previous score of an author, a reader, or a paper, the new score $s(t+1)$ is obtained as the weighted mean of j and $s(t)$:

$$s(t+1) \quad = \quad \beta \cdot j + (1 - \beta) \cdot s(t). \tag{1}$$

β is in the range $[0, 1]$ and indicates the importance of the new judgment with respect to the old score: if $\beta = 0$ the new judgment is not taken into account; if $\beta = 1$ the old score is not taken into account; if $\beta = 0.5$ the new judgment and the old score have the same importance and the new score is equally distant from old score and new judgment; and so on. The value of β depends on other parameters, that are different depending on the kind of score that is being updated, as we will see in the following sections. Figure 1 shows the dependence of $s(t+1)$ on $s(t)$ and j for three values of β ($\beta = 0.1$, $\beta = 0.5$, and $\beta = 0.9$) both in two dimensions (a) and in in three dimensions, representing $s(t+1)$ as a function of $s(t)$ and j (b), (c), and (d). Table 1 shows some values for $s(t+1)$.

Rewriting (1) as

$$s(t+1) \quad = \quad s(t) + \beta \cdot (j - s(t))$$

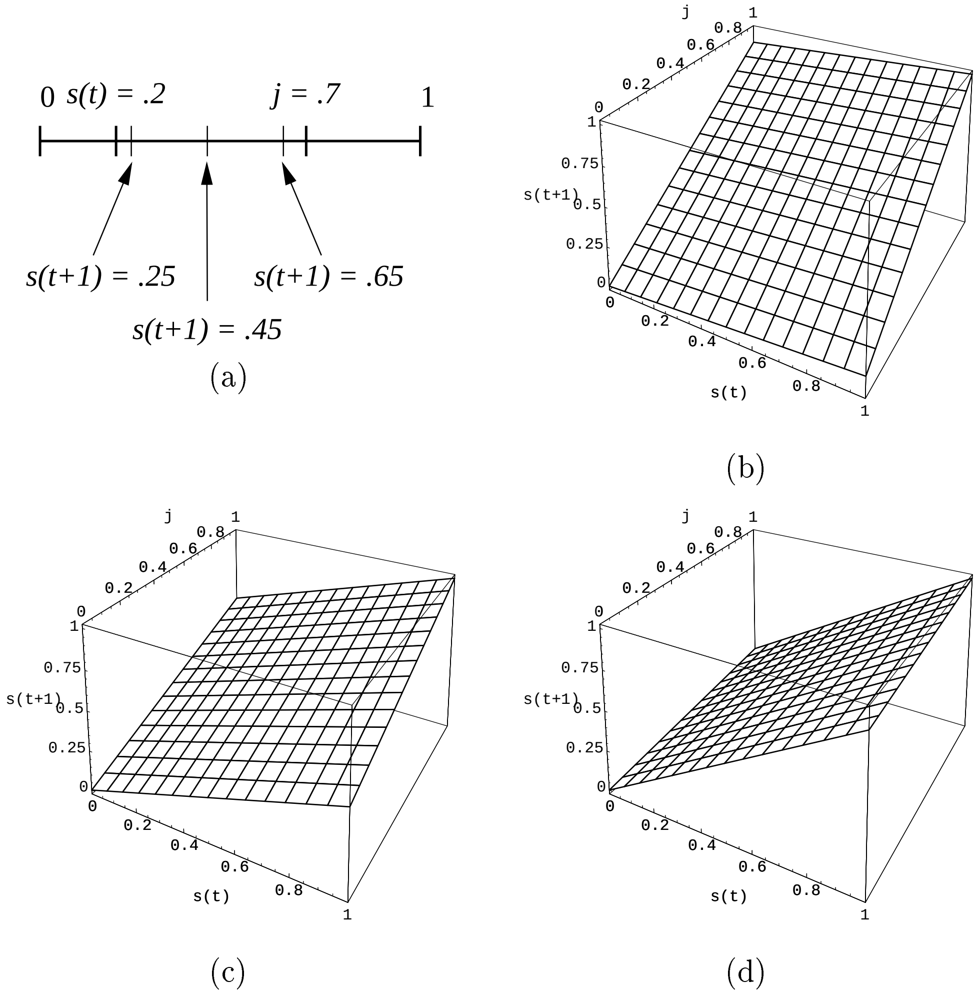

Figure 1: Variation of $s(t+1)$, as defined in (1). In a two dimensional view for $\beta = 0.1$, $\beta = 0.5$, and $\beta = 0.9$ (a) and in three dimensional view for $\beta = 0.1$ (b), $\beta = 0.5$ (c), and $\beta = 0.9$ (d).

	$s(t)$	j	β	$s(t+1)$
1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.5	0.1
3	0.1	0.1	0.9	0.1
4	0.1	0.5	0.1	0.14
5	0.1	0.5	0.5	0.3
6	0.1	0.5	0.9	0.46
7	0.1	0.9	0.1	0.18
8	0.1	0.9	0.5	0.5
9	0.1	0.9	0.9	0.82
10	0.5	0.1	0.1	0.46
11	0.5	0.1	0.5	0.3
12	0.5	0.1	0.9	0.14
13	0.5	0.5	0.1	0.5
14	0.5	0.5	0.5	0.5
15	0.5	0.5	0.9	0.5
16	0.5	0.9	0.1	0.54
17	0.5	0.9	0.5	0.7
18	0.5	0.9	0.9	0.86
19	0.9	0.1	0.1	0.82
20	0.9	0.1	0.5	0.5
21	0.9	0.1	0.9	0.18
22	0.9	0.5	0.1	0.86
23	0.9	0.5	0.5	0.7
24	0.9	0.5	0.9	0.54
25	0.9	0.9	0.1	0.9
26	0.9	0.9	0.5	0.9
27	0.9	0.9	0.9	0.9

Table 1: Some values for $s(t+1)$, from Formula (1).

it is emphasized how the new score $s(t+1)$ is obtained adding to (or subtracting from) the old score $s(t)$ a quantity depending on how much the judgment j is different from the old score $s(t)$.

4 Paper score updating

When a reader r reads a paper p and expresses a judgment j, the new paper score $s_p(t+1)$ is updated (step 1.). Following the approach represented by Formula (1), $s_p(t+1)$ is calculated as the weighted mean of the judgment j expressed by r and of the old paper score $s_p(t)$:

$$s_p(t+1) \;=\; \pi \cdot j + (1-\pi) \cdot s_p(t). \tag{2}$$

π, that has the same role as β in (1), depends on:

- The reliability of the judge, measured with the reader's score s_r. A "good" reader's judgment should have more effect than a "bad" reader's one.
- The steadiness of the paper σ_p. Typically, if a paper has a very high steadiness, the paper has been read by many readers, and its score should be quite stable. In this way, a new different score by another reader (even if a very good, *i.e.,* with a high score, one) will not heavily change the paper score.

We have the constraints on π summarized in Table 2. A simple linear function that satisfy these constraints is:

$$\pi \;=\; K_P \cdot s_r + (1-K_P) \cdot (1-\sigma_p) \tag{3}$$

for $0 \leq K_P \leq 1$. The constant K_P represents the relative importance of reader's score s_r with respect to paper steadiness σ_p: if $K_P = 0$ then reader's score is not taken into account at all, if $K_P = 0.5$ then the reader's score and the paper steadiness have the same importance, and if $K_P = 1$ then the paper steadiness is not taken into account at all. With the definition (3), π depends in a linear way on s_r and σ_p. Figures 2a–c represents this dependence, for three different values of K_P. For deciding a good value for K_P some experimental activity is needed; it seems anyway reasonable that the score of a very steady paper (*e.g.,* $\sigma_p = 0.8$) has not to change a lot, even if a very good reader (*e.g.,* $s_r = 0.8$) expresses a judgment quite different from the actual score. Therefore, K_P should be chosen such that σ_p is more important than s_r; $K_P = 0.2$ seems a good choice and in the following I will use this value unless explicitly noted.

Perhaps, this solutions leads to a score changing too quickly: π can easily assume high values (if s_r and σ_p have a uniform distribution, the probability that $\pi > 0.5$ is 0.5), while, for obtaining a more slowly changing paper score, π value has to be low (if $\pi \to 0$, $s_p(t+1) \to s_p(t)$). It would be possible to have a different, nonlinear, function for π that increases more slowly than (3). For instance, we could have

$$\pi \;=\; K_P \cdot s_r^{H_P} + (1-K_P) \cdot (1-\sigma_p)^{H_P} \tag{4}$$

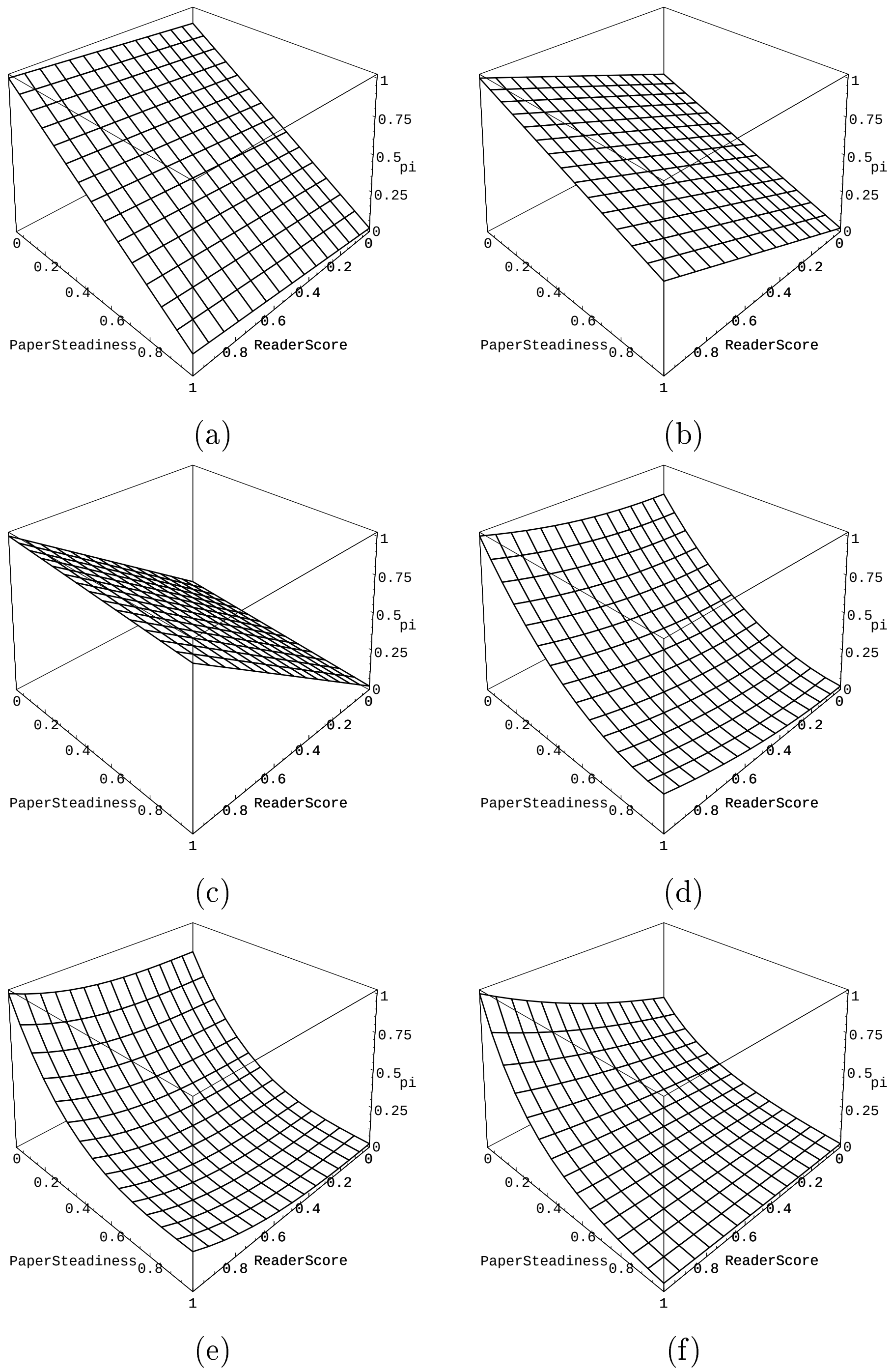

Figure 2: Variation of π, as defined in Formula (3), with $K_P = 0.2$ (a), $K_P = 0.5$ (b), and $K_P = 0.9$ (c), in Formula (4) with $H_P = 2$ (d) and $H_P = 3$ (e), and in Formula (5) with $H_P = 4$ (f).

		σ_p	
		0	1
s_r	0	$> 0, < 1$	0
	1	1	$> 0, < 1$

Table 2: Constraints on π.

	s_r	σ_p	π
1	0.1	0.1	0.52
2	0.1	0.5	0.05
3	0.1	0.9	0.0
4	0.5	0.1	0.54
5	0.5	0.5	0.06
6	0.5	0.9	0.01
7	0.9	0.1	0.66
8	0.9	0.5	0.18
9	0.9	0.9	0.13

Table 3: Some values for π, from Formula (4) with $H_P = 4$ and $K_P = 0.2$.

or

$$\pi = \frac{e^{H_P \cdot (K_P \cdot s_r + (1-K_P)\cdot(1-\sigma_p))} - 1}{e^{H_P} - 1}, \tag{5}$$

where the constant H_P (a positive integer) is useful for having a more slowly increasing curve (the higher H_P is, the slower the curve is increasing; with $H_P = 1$ in Formula (4) we obtain Formula (3) again) and the constant $K_P = 0.2$ has the same meaning as in (3). Figures 2d–f represent some of the functions that can be derived from (4) and (5) (note that $H_P = 2$ and $H_P = 3$ lead to two quite similar functions). For choosing the best function and constants, some experimental activity should be needed; in the following, I will use (2) (it is similar to (1), see Table 1 for some values) and (4) with $H_P = 4$ (Table 3 shows some values for π).

5 Author's score updating

A paper judgment causes also an updating of the score of the author of the paper (step 2.). The new author's score $s_a(t+1)$ is, following again the template (1), the weighted mean between the previous author's score s_a and the (new) paper score $s_p(t+1)$:

$$s_a(t+1) = \alpha \cdot s_p(t+1) + (1-\alpha) \cdot s_a(t). \tag{6}$$

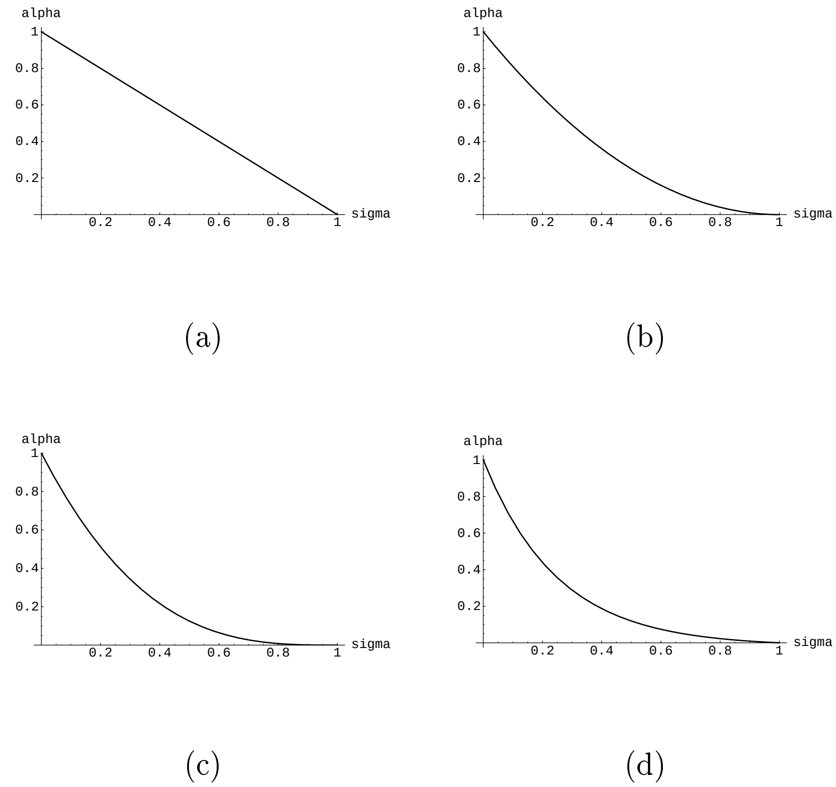

Figure 3: Variation of α, as defined in Formulae (7) with $H_A = 1$ (a), $H_A = 2$ (b), $H_A = 3$ (c), and (8) with $H_A = 4$ (d).

α depends on author's steadiness σ_a only: when σ_a is low (high), α must be low (high), since author's score has to change a lot only if it is not steady. We can choose (see Figure 3)

$$\alpha = (1 - \sigma_a)^{H_A} \tag{7}$$

or, for having an even more slowly increasing curve,

$$\alpha = 1 - \frac{e^{H_A \cdot \sigma_a} - 1}{e^{H_A} - 1}. \tag{8}$$

In the following I will use Formulae (6) and (7) with $H_A = 10$.

6 Reader's score updating

Also the reader's score s_r has to change when r expresses a judgment j (step 3.): the new score $s_r(t+1)$ is the weighted mean between the goodness g of the expressed judgment j

and the previous score s_r:

$$s_r(t+1) = \rho \cdot g + (1-\rho) \cdot s_r(t). \tag{9}$$

The goodness g also has to belong to $[0,1]$, and can be measured using the distance (*i.e.*, the difference in absolute value) between the reader's judgment j and the (new) paper score $s_p(t+1)$:

$$g = (1 - |j - s_p(t+1)|)^{H_G}. \tag{10}$$

(where H_G indicates how much the goodness increases). With this definition, $g = 1$ (the best judgment) if and only if $j = s_p(t+1)$, *i.e.*, the expressed judgment is equal to the new (and old) score of the paper.

ρ depends on:

- The steadiness of the reader σ_r: the more the steadiness of a reader, the less her score will change, and thus s_r is important. Intuitively speaking, if $\sigma_r = 1$, then the score of the reader does not change, and thus $\rho = 0$.
- The steadiness of the paper σ_p: the more a paper score is steady, the more the goodness of the judgment is important (or: the more a judgment distant from s_p is "bad"). If $\sigma_p = 1$ then $\rho = 1$.

We can then define ρ, as the weighted mean between σ_p and $1 - \sigma_r$, using a constant K_R indicating the relative importance of σ_p and σ_r, as already done for π with K_P. More generally, we can have:

$$\rho = K_R \cdot \sigma_p^{H_R} + (1 - K_R) \cdot (1 - \sigma_r)^{H_R}, \tag{11}$$

or

$$\rho = \frac{e^{H_R \cdot (K_R \cdot \sigma_p + (1-K_R)\cdot(1-\sigma_r))} - 1}{e^{H_R} - 1}. \tag{12}$$

In the following I will use Formulae (9), (10) with $H_G = 10$ and (11) with $K_R = 0.2$ (it has to be low for giving higher importance to σ_r) and $H_R = 1$.

7 Previous readers' scores updating

After the paper score has changed, it is possible to revise the goodness of the old readers' judgments, and to update the old readers' score consequently (step 4.): for instance, if an old reader r expressed a judgment j that was "bad" (distant from the paper score) at that time, but after that the paper score changes and becomes more similar to j, then s_r has to increase.

Let us take into account a simple concrete example (Figure 4):

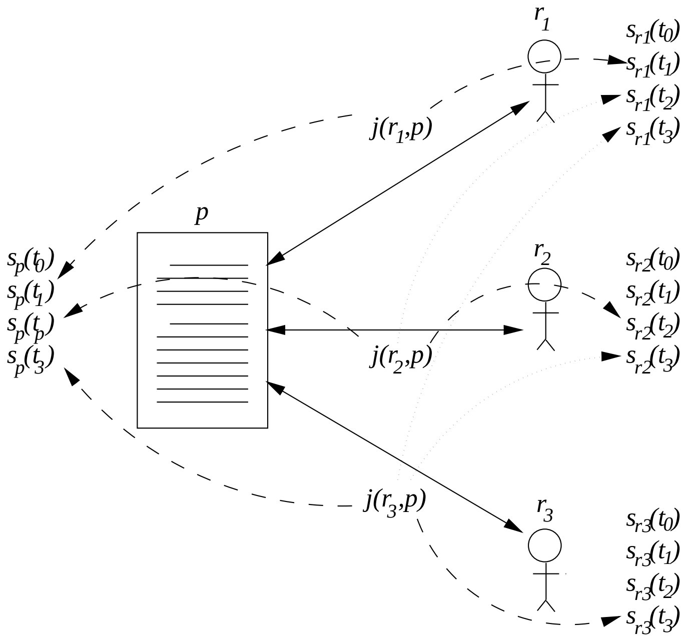

Figure 4: The updating of previous readers' scores.

- At time t_0 we have a paper p with score $s_p(t_0)$, three readers r_1, r_2, and r_3 with their scores $s_{r_1}(t_0)$, $s_{r_2}(t_0)$, and $s_{r_3}(t_0)$.
- At time $t_1 = t_0 + 1$ reader r_1 reads paper p expressing judgment $j(r_1, p)$ (continuous double arrow line in figure). This causes the updating of the scores of p and r_1 (dashed line in figure), with the previously seen Formulae (2) and (9): we obtain $s_p(t_1)$ and $s_{r_1}(t_1)$.
- At time $t_2 = t_1 + 1$ reader r_2 reads p expressing $j(r_2, p)$. The scores of p and r_2 are updated consequently, leading to $s_p(t_2)$ and $s_{r_2}(t_2)$. But also the score of r_1 has to be updated (dotted line in figure), since the goodness estimated at time t_1 for $j(r_1, p)$ with respect to $s_p(t_1)$ has to be re-estimated now that the score of p is $s_p(t_2)$.
- At time $t_3 = t_2 + 1$, r_3 reads p expressing $j(r_3, p)$. This changes the score of p ($s_p(t_3)$), the score of r_3 ($s_{r_3}(t_3)$), and the scores of the previous two readers ($s_{r_2}(t_3)$ and $s_{r_1}(t_3)$).

We have seen in the previous sections how to change the scores of the paper and of the reader that is expressing the judgment; I still have to define how to modify the scores of the previous readers. Let us take into account $j(r_2, p)$, that modifies p's score from $s_p(t_1)$ to $s_p(t_2)$. $s_{r_1}(t_1)$ was obtained, at time t_1, with Formula (9)

$$s_{r_1}(t_1) = \rho(t_1) \cdot g(t_1) + (1 - \rho(t_1)) \cdot s_{r_1}(t_0),$$

where the goodness of $j(r_1, p)$ was calculated at time t_1 with (10), on the basis of $s_p(t_1)$

$$g(t_1) = (1 - |j(r_1, p) - s_p(t_1)|)^{H_G}$$

and $\rho(t_1)$ was calculated at time t_1 with (11) on the basis of $\sigma_r(t_0)$ and $\sigma_p(t_0)$

$$\rho(t_1) \;=\; K_R \cdot \sigma_r(t_0)^{H_R} + (1 - K_R) \cdot (1 - \sigma_p(t_0))^{H_R}.$$

But s_p, σ_r and σ_p can now have changed (we will see in the next section how steadiness values are updated), as well as g and ρ. The new, more correct, values for g and ρ are:

$$g(t_2) \;=\; (1 - |j(r_1, p) - s_p(t_2)|)^{H_G}$$

$$\rho(t_2) \;=\; K_R \cdot \sigma_r(t_1)^{H_R} + (1 - K_R) \cdot (1 - \sigma_p(t_1))^{H_R}.$$

Therefore, the score of r_1 was not updated in a correct way, and it has to be re-calculated. We can obtain a more correct value for r_1's score subtracting the "wrong" value previously added, and adding the new "correct" value (note that, in general, it is not correct simply to start from $s_{r_1}(t_0)$, since this would lead to lose any eventual change to r_1's score happened between t_1 and t_2):

$$\begin{aligned} s_{r_1}(t_2) \;=\;& s_{r_1}(t_1) - \\ & (\rho(t_1) \cdot g(t_1) + (1 - \rho(t_1)) \cdot s_{r_1}(t_0)) + \\ & (\rho(t_2) \cdot g(t_2) + (1 - \rho(t_2)) \cdot s_{r_1}(t_0)) \,. \end{aligned} \tag{13}$$

Going on with our example, when, at time t_3, $j(r_3, p)$ is expressed, it modifies, besides p's score as usual ($s_p(t_3)$), r_2's score in a similar way:

$$\begin{aligned} s_{r_2}(t_3) \;=\;& s_{r_2}(t_2) - \\ & (\rho(t_2) \cdot g(t_2) + (1 - \rho(t_2)) \cdot s_{r_2}(t_1)) + \\ & (\rho(t_3) \cdot g(t_3) + (1 - \rho(t_3)) \cdot s_{r_2}(t_1)) \,. \end{aligned}$$

But $j(r_3, p)$ has to modify also r_1's score:

$$\begin{aligned} s_{r_1}(t_3) \;=\;& s_{r_1}(t_2) - \\ & (\rho(t_2) \cdot g(t_2) + (1 - \rho(t_2)) \cdot s_{r_1}(t_0)) + \\ & (\rho(t_3) \cdot g(t_3) + (1 - \rho(t_3)) \cdot s_{r_1}(t_0)) \,. \end{aligned}$$

This formula is correct because:

- $(\rho(t_2) \cdot g(t_2) + (1 - \rho(t_2)) \cdot s_{r_1}(t_0))$ is what was (wrongly) added because of $j(r_2, p)$;
- $(\rho(t_3) \cdot g(t_3) + (1 - \rho(t_3)) \cdot s_{r_1}(t_0))$ is what should have been added instead, given the new values.

In general, when a judgment j on a paper p is expressed by a reader r at time t, the scores of all the readers $r_i \neq r$ that previously read paper p at time t_i, respectively, have to be updated from $s_{r_i}(t-1)$ to $s_{r_i}(t)$ as follows:

$$\begin{aligned} s_{r_i}(t) \;=\;& s_{r_i}(t-1) - \\ & (\rho(t_x) \cdot g(t_x) + (1 - \rho(t_x)) \cdot s_{r_i}(t_i)) + \\ & (\rho(t) \cdot g(t) + (1 - \rho(t)) \cdot s_{r_i}(t_i)) \end{aligned} \tag{14}$$

where t_x is the time at which the last modification to s_{r_i} took place. Moreover, note that I have implicitly assumed that each reader can express only one judgment for each paper.

One could also go on and remark that the new values of the previous readers should be used to re-estimate the weight of the judgments previously expressed by them. For instance, when r_2 expresses $j(r_2, p)$ and causes r_1's score to change from $s_{r_1}(t_1)$ to $s_{r_1}(t_2)$, the score of the paper p should be re-estimated, since it depends on the score of the reader and this has just changed. But this seems to lead to a quite complicate situation, and perhaps to a never-ending loop, thus we stop here; the approximation obtained seems anyway a good one.

8 Steadiness updating

The steadiness values (of the paper being judged, of the reader expressing the judgment, and of the author) have also to be updated after a judgment (step 5.). The updating takes place in similar ways for readers, papers, and authors, by increasing the steadiness towards its maximum value 1. The amount of the increase is calculated using three constant $S_\sigma(x)$, where x stands for either p (paper), or a (author), or r (reader): if 0, no increment happens; if 1 the new steadiness is the maximum, 1; if 0.5 the new steadiness is the mean between the old steadiness and 1. The formula is:

$$\sigma_x(t+1) \quad = \quad (1 - S_\sigma(x)) \cdot \sigma_x(t) + S_\sigma(x), \qquad (15)$$

or

$$\sigma_x(t+1) \quad = \quad \sigma_x(t) + S_\sigma(x) \cdot (1 - \sigma_x(t));$$

the constants $S_\sigma(x)$ represent the speed of steadiness change for paper, reader, and author.

From Table 4, that shows some values for $\sigma_x(t+1)$, we can see that the ideal value for $S_\sigma(x)$ has to be quite low, since the changing in the steadiness takes place too fast. In the following I will use Formula (15) with $S_\sigma(p) = 0.001$, $S_\sigma(a) = 0.005$, and $S_\sigma(r) = 0.005$.

9 Some examples

For space limitations, I provide a simulation of two simple typical cases only: a low rated author that publishes a good paper and a paper that is initially judged in a wrong way.

Let us assume that an author a with score $s_a = 0.1$ and steadiness $\sigma_a = 0.1$ publishes a quite good paper p ($s_p = 0.9$), and that all the readers recognize that the paper is good, so that readers $r_1, r_2, \ldots, r_n$ give a judgment of 0.9 (Figure 4 can be seen as representing this situation with $n = 3$). Table 5 represents what happens to paper and author's score and steadiness values depending on n, showing that the score of the paper increases, as well as the score of the author (but more slowly). The steadiness values increase too.

Let us assume that the paper p is not a good paper, but that the first 10 readers judge it as a good one, like in the previous example. After that, the readers r_{11}–r_n judge it correctly, giving a judgment of 0.1. Table 6 represents what happens to paper and author's score and

	$S_\sigma(x)$	$\sigma_x(t)$	$\sigma_x(t+1)$
1	0.1	0.1	0.19
2	0.1	0.5	0.55
3	0.1	0.9	0.91
4	0.5	0.1	0.55
5	0.5	0.5	0.75
6	0.5	0.9	0.95
7	0.9	0.1	0.91
8	0.9	0.5	0.95
9	0.9	0.9	0.99

Table 4: Some values for $\sigma_x(t+1)$ from Formula (15).

steadiness depending on n: the first ten lines are the same as the those in Table 5, but the following lines show how paper and author's score decrease. Steadiness values increase, as it is intuitively correct.

10 Conclusions and future developments

I have described an electronic journal in which the standard peer review process is replaced by a more democratic approach based on judgments expressed by the readers.

Generally speaking, this proposal can be seen as an improvement of the dissemination of scholarly information through on line scholarly journals by improving the referee process and by making responsible the readers. More specifically, it can be seen as an improvement of the democratic journal proposed in [7], of collaborative information retrieval and filtering [5], since it allows to distinguish among "good" and "bad" collaborators, and of the well known impact factor mechanism.

This proposal is not free from *problems*. In general, one may wonder if democracy is a good approach to knowledge dissemination. Of course, it is difficult to have an objective opinion on that: it could be appropriate, or appropriate in some fields only, or not appropriate at all. I believe that only by further studying, and experimenting on, these ideas we can find an objective answer. More specific problems are briefly discussed in the following.

A problem is *lazy readers*: a reader can simply confirm the previously expressed judgments, giving to each read paper a score equal to its actual score. Two solutions seem suited here: give higher scores to fast readers (those that first read the papers), and do not show the paper score for a period after its publication (for instance, until when its steadiness reaches a certain value).

Another problem might be the *lobbies*, *i.e.,* people that agree in mutually giving high scores. This might not be a problem at all, if the whole system can be modified to behave, by choosing appropriate formulae and constants, in a way that discourages the lobbies; if this is not the case, the solution would probably be to implement some software able to detect

t	s_p	s_a	σ_p	σ_a
0	0.1	0.1	0.1	0.1
1	0.52	0.25	0.11	0.1
2	0.71	0.4	0.12	0.11
3	0.8	0.53	0.13	0.11
4	0.85	0.62	0.14	0.12
5	0.87	0.69	0.14	0.12
6	0.88	0.75	0.15	0.13
7	0.89	0.78	0.16	0.13
8	0.89	0.81	0.17	0.14
9	0.9	0.83	0.18	0.14
10	0.9	0.85	0.19	0.14
		...		
24	0.9	0.89	0.29	0.2
		...		
100	0.9	0.9	0.67	0.45

Table 5: An author with low score and steadiness that publishes a good paper.

such situations.

As already noted at the end of Section 7, the updating of the scores presented in this paper is an approximation of the ideal case. If this approximation is not reliable, a better one will have to be looked for. But the ideal case, if handled in a simpleminded way, could lead to infinite loops during the updating, so this has to be carefully planned (*e.g.*, looking for a fixed point).

Of course there are technical difficulties too, for instance the identification of subscribers, or the huge amount of storage needed for recording the papers, the subscribers's data, and the history of expressed judgments. But these can surely be successfully handled by data base and cryptography technology.

It is also easy to see some mandatory *improvements*:

- To deal with papers with more than one author. That should be easy: the initial paper score is the average of authors' scores, weighted on the basis of the importance of the contribution of each author to the paper, and the following judgments of the paper cause a modification of all the author's scores, similarly to what proposed above.

- To have two different scores for a subscriber which is both an author and a reader, for separating the two skills. More generally, we might have more scores, both for subscribers (authors and readers) and papers: comprehensibility, technical soundness, originality, experience as a reader, and so on. In this way, a more detailed evaluation is available. If just one single number is needed, a weighted mean of all the scores of a subscriber (or a paper) can be used.

t	s_p	s_a	σ_p	σ_a
0	0.1	0.1	0.1	0.1
		...		
10	0.9	0.85	0.19	0.14
11	0.62	0.8	0.19	0.15
12	0.44	0.73	0.2	0.15
13	0.33	0.65	0.21	0.16
14	0.26	0.58	0.22	0.16
15	0.21	0.52	0.23	0.17
16	0.18	0.46	0.23	0.17
17	0.16	0.41	0.24	0.17
18	0.14	0.37	0.25	0.18
19	0.13	0.34	0.26	0.18
20	0.12	0.31	0.26	0.19
21	0.12	0.29	0.27	0.19
22	0.11	0.26	0.28	0.19
23	0.11	0.25	0.29	0.2
24	0.11	0.23	0.29	0.2
25	0.11	0.22	0.3	0.21
26	0.11	0.21	0.31	0.21
27	0.1	0.2	0.31	0.21
		...		
100	0.1	0.12	0.67	0.45

Table 6: A paper initially judged good and later judged bad.

- To have more than one journal, with different acceptance thresholds: a paper (researcher) must have a score larger than the threshold for being published (subscribing). Younger researcher will subscribe to lower rated journals, and "first class" journals will accept only well established researchers. The mechanism presented in this paper can also be used as a complement, instead of a complete substitution, of the peer review: the initial score can be given by a standard peer review, an author with a low score can anyway submit her paper to an higher rated journal, and the paper will be refereed in the usual way.
- To allow the subscribers know why their score is decreasing, *i.e.,* which "wrong" judgment, or paper, causes that, and eventually let them revise their judgment or withdraw their paper.
- To introduce a kind of *rent function* for decreasing the score of subscribers that are inactive for long periods of time.
- To allow the readers to express, besides the numerical score(s), also a free text *com-*

mentary on the paper. The commentary can then be considered as a paper itself, and judged by other readers, but it is linked to the paper it comments, and the score of the commentary can affect the score of the paper.

- To simplify the updating of previous readers' scores. With the approach proposed in Section 7, all the values assumed by scores and steadiness, and all the expressed judgments on the paper being judged need to be recorded and easily accessible for updating the scores of the previous readers (see Formula (14)). This migth be simplified, even through some approximation; for instance, one might take into account a limited history only, disregarding what happened a long time ago.

Finally, I sketch how I intend to proceed with this line of research. I am already working on implementing a software simulator of the electronic journal proposed here (I used it for deciding some values of the constants in the previous sections). I also plan to use some models and techniques from physics (mechanics, dynamics, and thermodynamics), economy, and games theory for formally studying the behavior of the whole system and for studying other similar approaches.

These experimental and theoretical activities will allow to verify that the behavior of the system is correct and consistent and to choose in a more reliable way, on the basis of an analytical experimental activity and of a complete theoretical analisys, among the proposed formulae and constants for the updatings, or even to design different ones, since other constants values and formulae could reveal more suited. More in detail, a steadiness value ranging in $]0, +\infty[$ instead of $]0, +1[$ could be find more appropriate; other typical cases, besides those presented in Section 9, could be simulated, *e.g.,* what happens to a reader's score when she expresses a judgment that is correct but far from the average; it would be possible to understand if and how the order of the judgments expressed by the readers affect their final score, or if the initial conditions—*i.e.,* the number of initial readers, their score, and so on—are a critical factor for having a stable system; we might use a bet-like approach, in which each reader has some money and bets on some papers; and so on.

After that, the software for the complete system will be implemented, tested, and evaluated. An ideal environment for this experiments is a repository of preprints, like *xxx* (http://xxx.lanl.gov). I plan to execute some laboratory experiments (with simulated papers, authors, and readers) and some real life experiments, involving real users.

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References

[1] C. W. Bailey, Jr. Scholarly electronic publishing bibliography—Version 23: 2/1/99. Web document. http://info.lib.edu/sepb.html.

[2] S. Harnad. Learned inquiry and the net: The role of peer review, peer commentary and copyright. *Antiquity*, 71:1042–1048, 1997. ftp://ftp.princeton.edu/pub/harnad/Harnad/HTML/harnad97.antiquity.html.

[3] S. P. Harter. Scholarly communication and electronic journals: An impact study. *Journal of the American Society for Information Science*, 49(6):507–516, May 1998.

[4] J. Holoviak and K. L. Seitter. Earth Interactions—Trascending the limitations of the printed page. *JEP the Journal of Electronic Publishing*, 3(1), 1997. ISSN 1080-2711; http://www.press.umich.edu/jep/03-01/EI.html.

[5] M. Karamuftuoglu. Collaborative information retrieval: Toward a social informatics view of IR interaction. *Journal of the American Society for Information Science*, 49(12):1070–1080, 1998.

[6] M. Lesk. *Practical Digital Libraries: Books, Bytes, and Bucks.* Morgan Kaufmann, San Francisco, CA, 1997.

[7] Z. Nadasdy. A truly all-electronic journal: Let democracy replace peer review. *JEP the Journal of Electronic Publishing*, 3(1), 1997. ISSN 1080-2711; http://www.press.umich.edu/jep/03-01/EJCBS.html.

[8] V. H. Resh. Science and communication: An author/editor/user's perspective on the transition from paper to electronic publishing. *Issues in Science and Technology Librarianship*, 19, 1998. ISSN 1092-1206; http://www.library.ucsb.edu/istl/98-summer/article3.html.