Evaluating Scientific Work by Means of Diffusion

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Abstract

There are two approaches for evaluating scientific papers. The classic way is to choose well established representatives of the specific scientific community and have them evaluate their colleague's work. The other method of evaluation, the so called ***peer-evaluation*** method, is where peers (famous or otherwise) of the author evaluate the paper.

Peer-evaluation resembles the diffusion process in which a new substance spreads out to the whole solution. Similarly the new author and article are diffused among the scientific community, smoothing the level for accepting scientific papers.

Using the ***classic-evaluation*** system of accepting new papers, the average starting scientists writes their first number of articles as collaborators with a renowned scientist, thus gradually building up their image. Only afterwards do these authors dare to independently publish.

What are the pros and cons of both these types of scientific article evaluations?

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1 Pros and cons of the above types

1. The ***peer-evaluation*** supports the expansion of scientific papers at the expense of the paper's scientific level. The reason for this is because peer evaluation is usually less critical as a result of the inclination to evaluate others as the peer wants his or her articles to be evaluated.

2. The ***classical-evaluation*** favors excellence in science at the expense of the expansion of scientific articles. This has historical roots since at the initialization of peer review during modern times the evaluators were at a higher scientific level and therefore, demanded higher scientific standards..

   The drawbacks of the one method are the advantage of the other method, and vice versa. The relevant properties are quantity vs. quality.

2. Diffusion law

We can estimate using physical diffusion laws, the number of referee generations (iterations in the diffusion process) that need to pass to obtain an upper limit of any given standard deviation for the peer-evaluation compared to the classical one.

I would like to suggest the following improvement for the ***peer-evaluation*** process. In ***peer-evaluating,*** several referees evaluate the same document. I suggest giving each referee a ***compatibility-index.*** This index indicates the degree of agreement that the individual referee has with the other referees evaluating the same material. This ***compatibility-index*** will be attached to each referee and will be updated using some weighted function, after each new article is evaluated. Grouping of the referees reviewing the same article should also take into account the ***compatibility-index***, namely referees having similar ***compatibility-indexes*** would be grouped together. This method has the potential to weed out overcritical or overly permissive referees. It should be emphasized that the whole process of refereeing reinforces itself negatively or positively. Bad referees harm science by either silencing promising scientists or enabling weak scientists to continue producing mediocre science. Good referees encourage young promising scientists while silencing those who should be silenced.

3. A negative example

Any refereeing method has the possibility of misevaluation, in which bad articles are accepted, or even worse, having excellent articles rejected. Prof. Dan Schechtman, the Nobel Prize laureate in Chemistry for 2012, may serve as an example of rejecting scientific results and disqualifying ideas. Due to the prejudice of certain scientists and a faulty evaluating process, it took over three decades to have his ideas and findings become mainstream.

4. Theoretical background

The diffusion is described formally in Fig. 1, where $\phi(\vec{r},t)$ is the density of the diffusing material at location $\vec{r}$ and time t and $D(\phi,\vec{r})$ is a diffusion coefficient. Diffusion's visualization is shown in Fig. 2.

References

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Fig. 1 Diffusion equation

$$\frac{\partial\phi(\vec{r},t)}{\partial t} = \nabla \bullet \left[D(\phi,\vec{r})\nabla\phi(\vec{r},t)\right]$$

Fig. 2 Diffusion's propagation visualization