"Understanding the evolution of cooperation is one of this century's foremost scientific challenges." Mike Mesterton-Gibbons, page 1280

evidentiary value of a hit is equal to *P* in both cold and confirmatory cases.

The differences can be profound. In one case in California (The People v John Puckett), now on appeal, the Bayesian value of 1 in 1 million was allowed, whereas entry of the frequentist value of 1 in 3 was not permitted.

Some panels of experts have recommended the frequentist *NP* value (including the US National Research Council's Committee on DNA Forensic Science and the US Department of Justice's DNA Advisory Board). Others recommend the Bayesian value of *P*.

Crime laboratories are frequently unsure of which value to present, or whether to report both and leave it to the attorneys and judges. The proposed US National Institute of Forensic Science could help in solving this kind of problem.

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Statisticians and historians should help improve metrics

To develop and apply adequate metrics (*Nature* **464,** 488-489; 2010), a proper understanding of the methodology of measuring and of the phenomenon to be measured is essential.

Key contributors to the analysis of scientific metrics may therefore be statisticians and historians of science. Both groups urge caution in applying science metrics (see, for example, B. Lightman *et al. Isis* **100,** 1–3; 2009).

When substantiating claims about the prominence of researchers, science historians draw on publication numbers, citation numbers, invitations, editorial duties, awards, promotions, grant funding, membership of academies, honorary titles, institutional affiliations and links to other prominent scientists. But they rarely use these measures alone: rather they are used as indicators to supplement and vindicate thorough analysis (H. Kragh *An Introduction to the Historiography of Science* Cambridge Univ. Press, 1987).

Statisticians would add that, for most of the present popular measures, there is no properly defined model of the relation between variables, little attention to confounding factors, and ignorance about the uncertainty of the measures and how that uncertainty affects rankings derived from them (R. Adler *et al. Statist. Sci.* **24,** 1–14; 2009).

In addition, the feedback mechanisms that arise when scientists change their publishing and citing behaviour in order to maximize their metric outcome will be a major challenge in developing realistic models. For predictions from past to future successes, these challenges will intensify.

Being aware of these shortcomings of scientific metrics is crucial for any endeavour that aims to improve them.

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Nature's readers comment online

A selection of responses posted on *Nature*'s website to 'Let's make science metrics more scientific' by Julia Lane (*Nature* **464,** 488–489; 2010)

ILLUSTRATION BY DAVID PARKINS

Konrad Hinsen said:
Two fundamental problems with metrics in science are that quantity does not imply quality, and that short-term impact does not imply long-term significance. The real value of many scientific discoveries often becomes apparent only many years later. It would be interesting to evaluate metrics by applying them to research that is a few decades old. Would they have identified ideas and discoveries that we now recognize as breakthroughs?

Long-term services to the scientific community are undervalued by current metrics, which simply count visible signs of activity. Take the development of scientific software: a new piece of software can be the subject of a publication, but the years of maintenance and technical support that usually follow remain invisible.
e-mail: research@khinsen.fastmail.net

Martin Fenner said:
Another important motivation for improving science metrics is to reduce the burden on researchers and administrators in evaluating research. The proportion of time spent doing research versus time spent applying for funding, submitting manuscripts, filling out evaluation forms, undertaking peer review and the rest has become ridiculous for many active scientists.

Science metrics are not only important for evaluating scientific output, they are also great discovery tools, which may turn out to be more useful. Traditional ways of discovering science (such as keyword searches in bibliographic databases) are increasingly superseded by non-traditional approaches that rely on social networking tools for awareness, evaluations and popularity measurements of research findings.
e-mail: fenner.martin@mh-hannover.de

Luigi Foschini said:
In the same issue, you run a News Feature on large collaborations in high-energy physics (Z. Merali *Nature* **464,** 482; 201) — some 10,000 researchers in the case of the Large Hadron Collider (enough to fill a small city). People who build enormous instruments of course do great work that enables important parameters to be measured.

But the practice of listing as authors on papers anyone who just tightens bolts or brings in money is killing the concept of authorship and hence any chance of measuring the productivity of individuals. Should I include Steve Jobs on papers I publish simply because I use a Mac to analyse data and to write articles and books?
e-mail: luigi.foschini@brera.inaf.it

Björn Brembs said:
No matter how complex and sophisticated, any system is liable to gaming. Even in an ideal world, in which we might have the most comprehensive and advanced system for reputation-building and automated assessment of the huge scientific enterprise in all its diversity, wouldn't the evolutionary dynamics engaged by the selection pressures within such systems demand that we keep randomly shuffling the weights and rules of these future metrics faster than the population can adapt?
e-mail: bjoern@brembs.net

Readers can now comment online on anything published in *Nature*. To join in this debate, go to go.nature.com/4U9HWS.