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The Deteriorating State of Methods Development

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Opinion

Methods development is an important aspect of almost every major quantitative discipline (e.g. Statistics, Biostatistics, Mathematics, Machine Learning, etc.). It is primarily concerned with the creation, implementation, distribution, and maintenance of theoretical and empirical findings. Many of the most useful methods are implemented in the form of computer programs that solve complex quantitative problems for the larger research community. By establishing new methods-an enterprise that requires both art and science, a critical bridge between theory (i.e. theorems, corollaries, and lemmas) and application (i.e. data analysis) is formed. Unfortunately, methods development in modern times has been in a constant state of decline. For the last two decades, it has been -- and continues to be- attacked from four different directions: funding, development time, exposure (in the context of peer-reviewed publications), and most importantly, maintaining training and deployment of the people who can do the work. Let's examine each factor in detail.

Funding

In the 1990's, the NIH (National Institutes of Health) routinely funded grants to develop new methods through many of its centers and institutes (e.g., NIMH, NIDDK, NCRR, and NHGRI). However, by 2011 funding for methods development had been so severely cut that NCRR (National Center for Research Resources) was abolished entirely [1]. Interestingly, NCRR was replaced by NCATS (the National Center for Advancing Translational Science), which is chiefly concerned with funding clinical trials and other kinds of clinical research, not methods grants.

Development time

Methods development is almost always put at the service of some popular technology. In the fields of Statistical and Population Genetics for example, that means "genome sequencing". However, the rapid evolution of DNA-related technologies makes most newly emerging methods "out-of-date" shortly after they appear in print. Moreover, the combined effect of rapidly evolving technologies and reduced funding can be devastating in terms of shrinking the available time for developing new methods. As such, the window for success is incredibly short, which means that methods don't get developed and problems don't get solved.

Exposure

Sadly, almost every high-impact journal in the quantitative sciences has pushed Methods sections to the back of the research article (or possibly even to an Appendix or Supplementary Material), while allowing only a very limited amount of space for exposition, as though the methods used are the least important part of the work and trivial to understand. On the contrary, Methods sections should be at the forefront of the presentation of any scientific work, especially when the methods play a vital role in shaping the final results.

Who does the work

With the dual insults of stark reductions in the training of the next scientific generation, and "encouraged" retirements for senior investigators who are "not productive enough" (i.e., insufficient grant funding), the so-called "next-generation" of methods developers is both poorly mentored and poorly funded, and is perhaps weaker now than ever before [2,3]. In fact, there is a troubling counter culture among young methods developers that is far more concerned with whether a new method works, than with understanding why and how it works. This paradigm shift, albeit subtle, is of the utmost import. If we continue down this path, where methods are selected from a drop-down menu but never developed, then we will find ourselves in a position where there is no one to learn from, we will be unable to incorporate new knowledge with our accepted understanding, and ultimately science will cease to advance [4].

This is why we need to encourage and support methods development, especially by developers who are trained to understand the problems on which they work. A robust methods development infrastructure empowers science by creating an array of tools and ideas to solve real problems. In particular, well-trained developers can often find synergistic approaches

that liberate research efforts from simple prediction and imputation. This in turn moves researchers away from findings that are statistically significant but clinically and/or scientifically uninteresting. In summary, if we want to start thinking "outside of the box" again, and if we want to look somewhere other than "beneath the streetlight", then we must commit now, and whole-heartedly to a massive revitalization effort that restores methods development before it's too late [5].

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