



**A Proposed NISO Work Item:
Develop a Recommended Practice: Toward a Compatible
Taxonomy, Definitions, and Recognition Badging Scheme
for Reproducibility in the Computational and Computing
Sciences**

**Proposal for Consideration by the NISO Voting Membership
Approval Ballot Period: November 20-December 20**

The following proposed work item is submitted by:

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INTRODUCTION AND STATEMENT OF PROBLEM:

Publishers and researchers are placing greater emphasis on the practice of reproducibility as an essential ingredient of the scientific research process. Critical to the issue of reproducibility is the taxonomy used to define the various levels of reproducibility, and agreement on a standardized badging scheme that can be applied in the publishing process (and perhaps used as a currency in the academic rewards culture). As reproducibility begins to spread across the scholarly publishing landscape, recommended badging schemes and the related taxonomies are developing on an ad hoc basis—creating a need for some standardization.

Recognizing that reproducibility standards can vary across disciplines, this effort will focus on standardization across the Computational and Computing Sciences, although adoption by other disciplines would be encouraged.

RELATIONSHIP TO OTHER EFFORTS:

The following description of Reproducibility taxonomies and badging schemes underscores a need for NISO-sponsored effort to forge some agreement and eliminate differing schemes, with movement toward common vocabulary. Different taxonomies do not necessarily require reconciliation, however, for fields that have major overlap such as the computational and computing sciences, it is desirable to seek compatibility. Each of the badging frameworks listed below should be considered by the proposed NISO committee.

- ***The Association for Computing Machinery (ACM)***. The ACM approved a reproducibility badging scheme and taxonomy in 2016 (discussions at the ACM began in 2013). ACM developed several badges that can be integrated into the review and acceptance of papers. Badges proposed by the ACM include:

- *Artifacts evaluated - Functional.* This badge is applied to papers whose associated artifacts have successfully completed an independent audit. Artifacts need not be made publicly available to be considered for this badge.
- *Artifacts evaluated – Reusable.* The artifacts associated with the paper are of a quality that significantly exceeds minimal functionality. That is, they have all the qualities of the Artifacts Evaluated – Functional level, but, in addition, they are very carefully documented and well-structured to the extent that reuse and repurposing is facilitated. In particular, norms and standards of the research community for artifacts of this type are strictly adhered to.
- *Artifacts available.* This badge is applied to papers in which associated artifacts have been made permanently available for retrieval.
- *Results replicated.* The main results of the paper have been obtained in a subsequent study by a person or a team other than the authors, using, in part, artifacts provided by the author.
- *Results reproduced.* The main results of the paper have been independently obtained in a subsequent study by a person or team other than the authors, without the use of author-supplied artifacts.
- ***The Claerbout/Donoho/Peng Taxonomy.*** (This taxonomy, while differentiating between Reproducibility and Replication does not describe a set of badges.) In a 1992 paper, Jon F. Claerbout and Martin Karrenbach introduced the concept of reproducible research. Building on this paper, Stanford professor David Donoho, in 1995 reported “When we publish articles containing figures which were generated by computer, we also publish the complete software environment which generates the figures” and they also talk about “Integrating Reproducibility into Scientific Publications ...every computationally-generated figure and every computationally-generated table in an article would become linked to the code and the computational environment that produced the figure”. Following on the work of Claerbout and Donoho, Roger Peng, in 2006 reinforced the concept of replication – that is, the practice of arriving at the same scientific findings as another study albeit using different methods. To quote Peng et al “The replication of important findings by multiple independent investigators is fundamental to the accumulation of scientific evidence.” These definitions of Reproducibility and Replication have come to be known as the Claerbout/Donoho/Peng taxonomy. It is important to note that the definitions of reproducibility and replication are in conflict with those proposed by the ACM. In a paper prepared by Sandia National Labs, Heroux et al have proposed that the computational and Computing Sciences adopt the Claerbout/Donoho/Peng definitions of Reproducibility and Replicability. The proposed NISO committee would be a good forum to bring clarity to the conflicting views.
- ***The Center for Open Science.*** The Center for Open Science offers a badging framework to acknowledge Open Science Practices. The badges have been adopted by 41 journals in the life and social sciences (see <https://cos.io/our-services/open-science-badges/>

Three badges are offered:

- *Open Data*
- *Open Materials*
- *Preregistered*

While the Center for Open Science badging framework may be appropriate for the social and life sciences, they may not be useful in the computer science and computational sciences communities, and they do not specifically address the concepts of Reproducibility and Replicability.

PARTNERS AND PARTICIPATION

Potential stakeholders include:

Publishers and not-for-profit societies in the engineering and computer science fields; Industry Associations such as STM, and the academic library community.

Requisite expertise would include:

- Editorial
- Technical software replication and simulation
- Peer review
- Academic promotion and tenure (supposing the that the badging process may become a new currency in the P&T decision process)
- Funding agency policy makers
- Researchers/authors
- Software replication platform vendors

TIMELINE

It is hoped that this work can be fast-tracked due to the burgeoning interest and the gathering momentum behind the early badging systems.

- Topic Committee Review: November 16, 2018
- Appointment of working group: January 15, 2019
- Approval of initial work plan: February 15, 2019
- Completion of initial draft: April 15, 2019
- Completion of final draft: July 15, 2019
- NISO Recommended Practice: September 15, 2019

FUNDING

Modest funding may be needed to offset committee travel for the purpose of group collaboration and to socialize the effort to the wider scholarly communication community. Suggested funding sources include the Sloan Foundation, The Mellon Foundation, and the National Science Foundation.

SOURCES

- Claerbout, J. F. and M. Karrenbach (1992). Electronic documents give reproducible research a new meaning, in SEG Technical Program Expanded Abstracts 1992, Society of Exploration Geophysics, -- 601-604, <http://doi.org/10.1190/1.1822162>
- Buckheit, J.B. and Donoho, D.L., 1995. Wavelab and reproducible research. In Wavelets and statistics (pp. 55-81). Springer, New York, NY. http://statweb.stanford.edu/~wavelab/Wavelab_850/wavelab.pdf
- Peng, R.D., Dominici, F. and Zeger, S.L., 2006. Reproducible epidemiologic research. American journal of epidemiology, 163(9), pp.783-789. <https://doi.org/10.1093/aje/kwj093>
- Heroux, M., Barba L., Parashar M., Stodden V., Taufer M. (2018) Toward a compatible Reproducibility Taxonomy for Computational and Computing Sciences. Prepared by Sandia National Laboratories. <https://cfwebprod.sandia.gov/cfdocs/CompResearch/docs/SAND2018-11186.pdf>