On the Tools of Our Trade

I vividly recall the experience of walking down the halls of a library, on a top floor of an enormous building, carefully searching for that precious hidden book described by a bizarre combination of alphanumeric symbols. I remember photocopying thousands of pages of old journal articles and conference proceedings. And finally, I remember carefully labeling them to create my very own library. Ah, those were the days when research really did mean exhausting physical labor!

This column focuses on the powerful new digital tools that help us in our technical and scientific work. It is connected to my column in the last issue in that it continues to focus on hopefully useful information for young engineers and scientists. While I would like my columns to be relevant information for all readers, my bias toward academia is unmistakable.

DIGITAL IDENTIFIERS FOR RESEARCHERS AND FOR CREATIVE CONTENT

The first technology trend I wish to highlight is the adoption of persistent, searchable, and nonproprietary digital identifiers. Digital identifiers are becoming increasingly important on digital networks and, specifically, the Internet. First, the "Open Researcher and Contributor ID," known as OR-CID, is a digital identifier for individual researchers and content creators. The ORCID system is a nonproprietary tool becoming the standard across the industry: it is now required for authors of IEEE journal articles, for

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authors of essentially all other major publishers, and even by selected funding institutions.

I would argue that ORCID identifiers are a great tool for all scientists and, specifically, for those authors whose name is not unique, changes with time (such as due to marriage), relies upon a non-Latin writing system, or is sometimes presented in a different format. In my extreme view, the only problem is that no publisher has so far agreed to retroactively add ORCID identifiers to the metadata of existing published works. See https://orcid.org for more information and to create your own identifier.

Second, articles and other creative works may be described by a "Digital Object Identifier," known as a DOI. It is becoming increasingly true that recent journal articles are all identified by a unique DOI and their reference lists ideally contain the DOI for the references they cite. The DOI of a creative work (such as articles) provides a URL to locate the work on the Internet: following a DOI link leads the reader to the website from which the official document can be downloaded. Because of their uniqueness, persistence, and ability to locate the corresponding work online, including DOI information in the list of references is a great way to improve the value and accuracy of references in your technical work.

I conclude this section with a kind suggestion to you all about DOIs: please do not be lazy and take the time to add DOI links to all your references (your readers will love you!). And if you post unofficial copies of your work on your website or the arxiv.org (for a discussion about green open access, read my last column or search the web), add the DOI to the unofficial copies so that your readers can always find the final official version.

REUSE FRIENDLY COPYRIGHT LICENSES

The nonprofit organization Creative Commons is the most established provider of copyright licenses that have reuse-friendly features and are offered free of charge. Creative Commons offers a wide range of worldwide copyright licenses, all the way from an "all rights reserved" license to a "public domain license." A content creator can choose to leave the user with the ability to edit, mix, and share the document and/or can offer commercial or noncommercial reuse rights. In other words, varying levels of openness and collaboration are possible. These Creative Common licenses have been vetted by lawyers and upheld in some courts around the world. For more information, see https://creativecommons.org.

Second, it is potentially useful to be informed about venues that share

resources with reuse-friendly copyright licenses. The websites Pixabay.com and Unsplash.com offer images with reuse-friendly copyrights. For example, Unsplash images may be used free, "including for commercial purposes." It is hard, however, to find high-quality vector images and diagrams illustrating engineering artifacts and with reuse-friendly copyrights. My suggestion is to generate your own with a proper software tool. Some useful sketches to use as a starting point may be found at Openclipart.org and Pixabay.com.

Finally, one may be interested in venues that publish creative work with reuse-friendly copyright licenses. Since I touched upon this topic in my last column, I will be brief. A key resource is the arXiv repository (pronounced "archive") for electronic preprints. This repository is a well-known resource of increasing importance and, indeed, the IEEE Control Systems Society (CSS) volunteers help moderate submissions in the control area. One final possibility is self-publishing books via online print-on-demand platforms that typically allow the author to retain most copyrights.

MY FAVORITE SOFTWARE TOOLS

A wide range of software tools has become everyday necessities over the last decades. A meaningful review of these tools is well beyond the scope of this section and column. In what follows, I highlight a selection of favorite software tools to provide useful suggestions to novices.

It is often said that "the best things in life are free" and, as far as computers are concerned, many of them are freely available on a UNIX command line. Command-line tools are widely available on any platform. For example, I find ssh and rsync useful programs to handle secure connections (such as those to fast computational servers) and remote backups. I also find the "make" command a great tool to carefully design sequences of actions, record them for future use, and organize my workflow.

As far as document preparation systems are concerned, free offerings include editors such as emacs and the LaTeX/BibTeX tools. It is worth noting that emacs (and its early competitor vi) is one of the oldest application programs in existence. LaTeX is now broadly available through the state-of-the-art TeX Live distribution. One creative use for your personal BibTeX database is to create ad-hoc fields to record information such as funding sources, extended bibliographical information, and miscellaneous reminders.

Diagramming, vector drawing, and digital illustration software have improved dramatically over the last decade. It is now finally possible, and relatively easy, to import and manipulate vector graphics, include LaTeX-based mathematical formulas, and edit individual graphic elements for clarity and illustration. There are both open-source and commercial software solutions. It is hard to underestimate the importance of these tools: in modern teaching, publishing, proposal writing, and public speaking, one truly needs to be able to illustrate and visualize complex ideas in the best of possible ways.

I cannot imagine working on documents without sharing and communication tools such as video conferencing, collaborative online document editors, and version control systems. Regarding video conferencing, after decades of watching sci-fi movies, we are finally living in the age of face-to-face and multiparty calls! All major offerings are from commercial entities (easy to find online) and offer quite reasonable free versions. Unfortunately, there is no standard or best solution, and it

While hard to visualize today, a key research tool of ancient times was the library. This photo is courtesy of Neil Cooper and is freely downloadable on Unsplash. Unsplash.com, like Pixabay.com and others, is a website dedicated to sharing photographs with a reuse-friendly copyright for both commercial and noncommercial purposes.

is inconvenient to have to install and adjust to different tools to meet with different people. Collaborative online document editors (mostly from commercial entities) and version control systems (such as the open-source CVS, Subversion, and Git) are also great ways to share documents and work collaboratively. Version control systems are essential for software development but may be less established for collaborative document editing. However, they are very flexible (clearly better than simply sharing a directory) and a natural match with a workflow based on LaTeX/BibTeX.

Finally, bibliometric tools (that is, citation and impact analysis tools) are often consulted as a means to follow the publication record of a scholar and, sometimes, unfortunately overly relied upon in the evaluation of said

scholar. Ideally, citation counts should be connected with ORCIDs and DOIs, but for now most tools are proprietary and connected with a commercial entity. The academic Eigenfactor Project, at http://www.eigenfactor.org, features valuable analysis tools for journal impact and other bibliometric indicators.

CONCLUDING REMARKS

Finally, I would be remiss if I did not mention that the IEEE provides its own set of digital author tools at the

website http://ieeeauthorcenter.ieee.org. Featured items include the IEEE PDF Checker, IEEE Article Templates, and a monthly newsletter, among others.

As always, your comments, suggestions, and ideas on this column and on how to improve activities of the Society are very welcome. I can be reached at bullo@ucsb.edu.
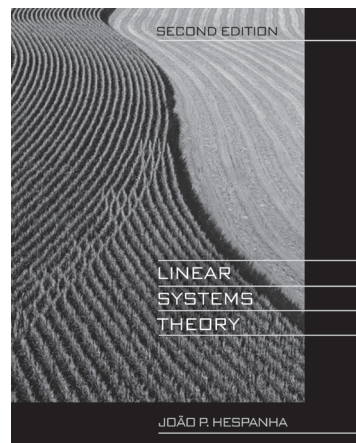
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