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IEEE Signal Processing Magazine and University Rankings

recently had the privilege of reading a report by Prof. Domingo Docampo, of the University of Vigo, about research impact and research rankings. What I learned was surprising. I also had the pleasure of having several email exchanges with him regarding this editorial, and I've included some of his observations.

One of the main rankings of universities worldwide is the Academic Ranking of World Universities (ARWU), sometimes called the ShanghaiRanking [1]. Unlike the U.S. News & World Report global rankings [2], which U.S. universities use most often, the ARWU ranks universities around the world based on a combination of five quantitative inputs and does not incorporate research reputation ranking indicators, which are derived from surveys, or teaching aspects. Based on discussions with international colleagues, I believe that the ARWU is the most commonly accepted ranking outside the United States.

The ARWU provides rankings for different academic subjects. The most recent list of these subjects in engineering is presented in Table 1. The list of subjects in engineering includes the core engineering areas around which departments are built in the United States, such as mechanical, electrical and electronic, civil, biomedical, and chemical. There are also topics such as telecommunications engineering (more on this later), which find departments at universities outside

Digital Object Identifier 10.1109/MSP.2019.2894485 Date of publication: 26 February 2019 the United States and is considered to be equivalent in most ways to electrical engineering in the United States.

Other examples in this category include automation and control or marine/ocean engineering. A few subjects are more spe-

cialized and may be topics of research centers but not necessarily for academic units, such as nanoscience and nanotechnology or remote sensing. A striking observation is that there is no subject dedicated to signal processing.

Five quantitative metrics are used to compute the ranking for a given university. PUB is the total number of "paper type" publications during a five-year period and is obtained from Clarivate Analytics. CNCI is a normalization of the papers from PUB based on the average citations in the appropriate

subject area. TOP indexes the top journals in a given area that have been identified by an academic survey (like

Five quantitative metrics are used to compute the ranking for a given university. in electrical and electronic engineering) or by selecting from the InCites Journal Citation Report (JCR) top 20% journals ac-

cording to their impact factors (e.g., telecommunications engineering). IC is the number of papers with collaborators from two different countries. The most recent rankings, from 2018, were computed based on publications from 2012 to 2016. AWD is the number of people who have received what is considered the top prize in that field (for example, the IEEE Medal of Honor in electrical and electronic engineering). The data in each category are processed and the results are weighted together. More

Table 1. ARWU academic subjects in engineering.

- Mechanical engineering
- Electrical and electronic engineering
- Automation and control-telecommunication engineering
- Instruments science and technology
- Biomedical-engineering computer science and engineering
- Civil engineering
- Chemical-engineering materials science and engineering
- Nanoscience and nanotechnology

- Energy science and engineering
- Environmental science and engineering
- Water resources
- Food science and technology
- Biotechnology
- Aerospace engineering marine/ocean engineering transportation science and technology
- Remote sensing
- Mining and mineral engineering
- Metallurgical engineering

details about the calculation methodology may be found in [3].

To summarize, a paper with a university-affiliated author contributes to the rankings in the following ways. A published paper will impact PUB when the journal is listed in the appropriate JCR. If the paper has coauthors from different countries, then it will impact the IC indicator. The quality of the paper as measured by its number of citations

impacts the CNCI value. If the paper is published in a special class of journals, then it also impacts the TOP classification.

So how does an article published in

IEEE Signal Processing Magazine (SPM) impact the ARWU ranking? According to recent results from JCR, SPM only appears in the electrical and electronic engineering subject area. Furthermore, in this area, the only TOP journal is IEEE Proceedings. As a result, SPM articles impact the PUB area by virtue of being published, the CNCI category as those papers are often highly cited, and the IC indicator since most articles have a geographically diverse group of authors. Note that SPM does not impact the TOP indicator because only a single journal was chosen.

In some cases, application-oriented signal processing may be found in another subject area for that application. For example, in the telecommunications engineering category, there are 18 publications listed, including the IEEE Signal Processing Society comanaged journals *IEEE Transactions on Multimedia* and *IEEE Transactions on Multimedia* and *IEEE Transactions on Wireless Communications*. Apparently, in telecommunications there was no agreement on the top publications, and so the 20% of the journals with the highest impact factor were assembled on a list. *SPM* and journals that publish related material like *IEEE Transactions on Signal Processing*, though, are missing. As a result, research by the Signal Processing for Communications and Networking Committee (SPCOM) published in *IEEE Transactions on Wireless Communications* has an extra contribution in TOP versus just PUB and CNCI categories when the same work is published in *IEEE Transactions on Signal Processing*. The impact for *SPM* articles is the

The impact for *SPM* articles is the same as in the case of electrical and electronic engineering because *SPM* is also not in TOP. anc work is published ions on Signal Processfor SPM articles is the same as in the case of electrical and electronic engineering because SPM is also not in TOP. Why not publish SPCOM overview papers instead in IEEE Comgazine, IEEE Wireless

munications Magazine, IEEE Wireless Communications, or IEEE Vehicular Technology Magazine, which were recently included in the TOP category? The reason is that those magazines publish articles that usually have only one equation (Yikes!), approximately 15 references, and roughly seven doublecolumn pages. It would be difficult to reformat a typical SPM special issue article or feature article to fit within those requirements!

There are a few ways that SPM could have more impact. First, it would be nice if SPM was included in more subject areas. For example, IEEE Communications Magazine is included in both electrical and electronic engineering and telecommunications, while IEEE Access is included in electrical and electronic engineering, telecommunications, and computer science information systems. The inclusion of journals into subject areas is part of the JCR, using methods that are not described in detail. As a result, it is not clear what it would take for SPM to be counted in a more diverse set of subject areas. Second, it would be great if the electrical and electronics engineering area included the top 20% of papers, not just *IEEE Proceedings*, in the TOP category. As *SPM* is currently ranked ninth, it would certainly be included in the top 20%. Electrical engineering is so diverse, including a larger cross section of top journals is reasonable.

Overall, signal processing seems to be short-changed in the current subject classifications. As Dr. Docampo pointed out to me, from JCR, electrical and electronic engineering has 260 journals with roughly 1.6 million citations. Computer science has similar statistics but broken up across six different categories including artificial intelligence, cybernetics, hardware and architecture, interdisciplinary applications, software engineering, and theory and methods. The reason seems to be that engineering and computer science are treated on the same level. Electrical and electronic engineering is one of many categories of engineering. Given the diversity of research in electrical engineering, though, it makes sense to me that electrical and electronic engineering is also split, with one resulting piece corresponding to signal processing. This categorization, though, is determined by JCR and is used in the ARWU rankings. With more emphasis on signal processing, the impact of signal processing research would be better represented in journal and university rankings.

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