Christian Jutten | Editor-in-Chief | Christian.Jutten@grenoble-inp.fr

Think Outside the Box!

Summer is a nice, quiet period, with the end of the academic year in many countries. It is a time for vacations and to think about events and develop a vision for our future. Of course, this vision is based on current research results, biased by fashion effects and *publish or perish* tendencies and perturbated by the COVID-19 pandemic, which, in depth, modifies our life—professional as well as personal.

First, I would like to evoke the memory of Prof. Jeanny Hérault, who died on 7 June 2021. Since 1970, Jeanny had been a faculty member at the Polytechnic Institute and then at the University Joseph Fourier in Grenoble, France, and he trained dozens of Ph.D. students, postdocs, and young researchers. He was my Ph.D. supervisor before becoming my friend, and I am sure that most of you understand from your own experiences how strong our friendships could be. Some of you knew him as well as his contributions: he was actually an *out-of-the-box* scientist. In this editorial, I will recall some of his outstanding contributions around signal processing.

Very early on, Jeanny was fascinated by the brain, as it is a fantastic machine for signal processing. When he decided to prepare a Ph.D. in 1968, he chose a topic fully *out of the box* focused on modeling neural cells and simulating them on electronic circuits. And then, during his entire career, he proposed innovative methods in signal and image processing always inspired by brain and human vision, including artificial neural networks. In early 1980, inspired by modeling how the brain of vertebrates can decode arm and leg motions, he proposed the basics of blind source separation and independent component analysis [1]. In the 1990s, since computers were not powerful enough to run artificial neural networks, Carver Mead [2] in the United States and a few scientists around the world developed, like Jeanny and several of his Ph.D. students, a few special architectures able to train and efficiently use neural networks such as multilayer perceptrons and self-organizing maps [3]. He then developed the concept of curvilinear component analysis, which extends the Kohonen's maps to huge-dimension data and implicitly considers high-dimension data are embedded in a low-dimension manifold with suited non-Euclidian metrics [4]. Finally, in the mid-1990s, he focused on modeling retina, first the neural layers after the retina and more generally vertebrate visual perception, for understanding how motions, textures, colors, etc., are processed in the brain. These works result in many powerful bioinspired algorithms, as well as applications and patents, which are summarized in his very inspiring book *Vision: Images, Signals and Neural Networks. Models of Neural Processing in Visual Perception* [5] published in 2010. Finally, just after he retired, he created a nonprofit association in Grenoble, open to any curious person, called Neurocercle (https://neurocercle.wordpress.com), and each month since 2009, he has invited a scientist to talk about advances in neurosciences and cognitive sciences and implications in our lives.

Prof. Jeanny Hérault, keynote speaker at the IEEE MLSP 2009 workshop, in Grenoble, France.

In this issue

Three feature articles are the core of this issue of *IEEE Signal Processing Magazine* (*SPM*). They are focused on the processing of data, especially large data in high dimension, using signal processing and machine learning methods. Clearly, in these articles, an essential ingredient is the data. The usual way is to process always larger data sets, larger high-dimension data with very powerful, multicore computers. The articles point out different tricky learning issues in data sets, i.e., how to deal with unbalanced

(continued on page 5)

Digital Object Identifier 10.1109/MSP.2021.3086574
Date of current version: 27 August 2021

colleagues have leveraged signal processing tools to advance machine learning. No one has exclusive ownership of any intellectual construct or tool. Transformational innovations that result from creative insights and cross disciplinary synergies deservedly get the limelight. That is precisely what we should focus on.

To foster innovation and unconventional thinking, we're also inviting you to participate in a number of online webinars and town halls. New this year are town halls for you to meet candidates for the president-elect position. These town halls will give you an opportunity to ask candidates direct questions about issues that are dear to you or suggest to the candidates the initiatives that will benefit all of us. The webinars will focus on strategic planning, as I indicated in a previous column. I urge you to bring innovative ideas to these webinars. For example, building on the lessons we've learned from virtual conferences in the COVID-19 era, some of our computer science colleagues are promoting the idea of periodic paper submission opportunities, followed by a fast and rigorous review process and immediate presentation in virtual meetings. Such an approach has the advantage of quick validation and interactive dissemination of innovation without sacrificing review quality, in contrast to the current latency built in our journal and even conference publication mechanisms. Should we explore such unconventional publication fora?

SP

FROM THE EDITOR

(continued from page 3)

classes, with missing data, with too-small data sets, etc. The articles suggest smart solutions for overcoming these problems, e.g., how one can artificially generate additional relevant data for completing missing or unbalanced data, or how one can use transfer learning for reducing learning time and complexity. Thus, based on even larger completed data sets, requiring higher computational loads, performance can be improved.

However, there is another unusual way to address the scale problem of processing huge data sets, an *out-of-the-box* idea perfectly illustrated by the first feature article "Sketching Data Sets for Large-Scale Learning" in this issue of *SPM*. Instead of enlarging the data sets, the basic idea of sketching is to only keep the data you need. The idea of sketching is particularly intelligent as well as ecological. Faced with huge data learning, the main principle of sketching is to extend the concept of compressive sensing to compressive learning, i.e., to extract a small number of lower-dimension features based on averaged nonlinear mappings of the initial data. This idea presents many advantages: it avoids storing huge data in memory; it leads to much faster learning algorithms, able to run on simple embedded devices; it can achieve similar or even better performance than using the complete data sets. Sketching is also able to preserve data privacy, which is very important when using sensitive data.

Of course, it is much more comfortable to do incremental research, following the current flow of research. Sure, it is risky to be *out of the box*: it requires a lot of effort to explain new ideas, and it also will take longer and be more difficult to be published. But, I believe that such *out-of-the-box* ideas are actually mandatory for innovation and science advances. So, dare to investigate these a little crazy and *out-of the-box* ideas!

References

[1] C. Jutten and J. Hérault, "Blind separation of sources, part I: An adaptive algorithm based on neuromimetic architecture," *Signal Process.*, vol. 24, no. 1, 1991, pp. 1–10. doi: 10.1016/0165-1684(91)90079-X.

[2] C. Mead and M. Ismail, *Analog VLSI implementation of neural systems*, (The Kluwer International Series in Engineering and Computer Science). Norwell, MA: Kluwer Academic Publishers, 1989, vol. 80.

[3] J. C. Lawson, N. Maria and J. Hérault, "SMART: neurocomputer using sparse matrices," in *Proc. Euromicro Workshop on Parallel Distrib. Process.*, 1993, pp. 59–64. doi: 10.1109/EMPDP.1993.336420.

[4] P. Demartines and J. Hérault, "Curvilinear component analysis: A self-organizing neural network for nonlinear mapping of data sets," *IEEE Trans. Neural Netw.*, vol. 8, no. 1, pp. 148–154, 1997. doi: 10.1109/72.554199.

[5] J. Hérault, "Vision: Images, signals and neural networks," in *Models of Neural Processing in Visual Perception*. World Scientific, 2010. doi: 10.1142/7311.

SP