

Rodrigo Capobianco Guido^{ID}, Tulay Adali^{ID}, Emil Björnson^{ID},
 Laure Blanc-Féraud^{ID}, Ulisses Braga-Neto^{ID}, Behnaz Ghoraani^{ID}, Christian Jutten^{ID},
 Alle-Jan Van Der Veen^{ID}, Hong Vicky Zhao^{ID}, and Xiaoxing Zhu^{ID}

IEEE Signal Processing Society: Celebrating 75 Years of Remarkable Achievements (Part 2)

It is our great pleasure to introduce the second part of this special issue to you! The IEEE Signal Processing Society (SPS) has completed 75 years of remarkable service to the signal processing community. The eight selected articles included in this second part are clear portraits of that. As the review process for these articles took longer, however, they could not be included in the first part of the special issue, and we are glad to bring them to you now.

In the first article, “Audio Signal Processing in the 21st Century,” Richard et al. [A1] provide an overview of the long history of research on audio and acoustics, including the analysis and modeling of room acoustics, generation of artificial reverberation, spatial rendering, echo cancellation, dereverberation, acoustic feedback control, source separation, music information retrieval, plus other related and relevant topics.

Next is the second article, “Twenty-five Years of Evolution in Speech and Language Processing,” by Yu et al. [A2], who describe major breakthroughs in each of the following speech processing subfields: language processing, automatic speech recognition, speech synthesis, speech coding, speech enhancement, speaker recognition, language identification, language understanding, dialog systems, and deep learning. They also comment on the main driving forces that

led to the current state of the art in the field. The societal impacts and potential future directions are complementarily discussed by them.

The third article in this special issue is “The Foundations of Computational Imaging,” where Fowler et al. [A3] present historical perspectives on the field of computational sensing and imaging, providing some context on how it has arrived at its present state as well as on its role within the SPS. Physics-driven imaging and explicit inverse operators, optimization formulation, and model-based reconstruction, in addition to data-driven models and machine learning for image processing, are among the main details discussed.

“Superresolution Image Reconstruction: Selective Milestones and Open Problems” is the title of the next article, in which Li et al. [A4] present a systematic review of the evolution of superresolution methodology in the past 25 years with an emphasis on theoretical insights, complemented with various well-cited superresolution algorithms, and the progression in both model- and learning-based approaches, in addition to open challenges in the field.

The fifth article, “Information Forensics and Security: A Quarter Century Long Journey,” is authored by Barni et al. [A5]. They present an introductory section providing the context in the 1990s, where readers could find the main knowledge and technological challenges, focus areas such as

digital watermarking, steganography, steganalysis, biometrics, multimedia forensics, and adversarial signal processing. Finally, they present future trends in the domain and a discussion about the unethical use of information security tools.

In the next article, “Signal Processing for Brain–Computer Interfaces: A Review and Current Perspectives,” Wu et al. [A6] cover the wide field of brain–computer interfaces, particularly discussing the history, types, and general flow of those interfaces, including key related aspects such as signal filtering, blind source separation, time-frequency analysis, compressive sensing, and machine learning. Future directions on the field, with pros, cons, and tradeoffs, are also presented by the authors.

“Networked Signal and Information Processing,” authored by Vlaski et al. [A7], overviews the very significant advances in networked signal and information processing that have enabled extending decision making and inference, optimization, control, and learning to the increasingly ubiquitous environments of distributed agents. Taxonomies, networked algorithms, and stochastic optimization are among the key aspects explored by the authors, who carefully address the most relevant aspects that have dominated the field over the previous decades.

The final article in this special issue is “Seventy Years of Radar and Communications: The Road from Separation

to Integration,” where Liu et al. [A8] present an introduction to the field accompanied by key concepts such as information delivery and acquisition, basic principles of radar and communications, and the integration of sensing and communications. The early development of radar and communications, spectrum engineering, and multiple-input, multiple-output antenna arrays are additional relevant topics discussed by the authors, who conclude their article with a discussion on open challenges and future research directions in the field.

This concludes the second part of this special issue. Once again we express our gratitude to all the contributing authors and reviewers, in addition to our administrative staff: Rebecca Wollman, who consistently helped us with all the administrative details, and the efficient team led by Sharon Turk, who carefully supervised the editorial process, taking care of every detail.

We sincerely hope you enjoy reading this second part of the special issue and that you, as a member of the SPS, feel represented by the articles we have selected for your perusal.

Acknowledgment

Rodrigo Capobianco Guido is the lead guest editor of this special issue.

Guest Editors



Rodrigo Capobianco Guido (guido@ieee.org) received his Ph.D. degree in computational applied physics from the University of São Paulo (USP), Brazil, in 2003. Following two postdoctoral programs in signal processing at USP, he obtained the title of associate professor in signal processing, also from USP, in 2008. Currently, he is an associate professor at São Paulo State University, São José do Rio Preto, São Paulo, 15054-000, Brazil. He has been an area editor of *IEEE Signal Processing Magazine* and was recently included in Stanford University’s rankings of the world’s top 2% scientists. His research interests include signal and speech processing

based on wavelets and machine learning. He is a Senior Member of IEEE.



Tulay Adali (adali@umbc.edu) received her Ph.D. degree in electrical engineering from North Carolina State University. She is a distinguished university professor at the University of Maryland, Baltimore County, Baltimore, MD 21250 USA. She is chair of IEEE Brain and past vice president of technical directions for the IEEE Signal Processing Society (SPS). She is a Fulbright Scholar and an SPS Distinguished Lecturer. She received a Humboldt Research Award, an IEEE SPS Best Paper Award, the University System of Maryland Regents’ Award for Research, and a National Science Foundation CAREER Award. Her research interests include statistical signal processing and machine learning and their applications, with an emphasis on applications in medical image analysis and fusion. She is a Fellow of IEEE and a fellow of the American Institute for Medical and Biological Engineering.



Emil Björnson (emilbj@kth.se) is a full (tenured) professor of wireless communication at the KTH Royal Institute of Technology, Stockholm, 100 44, Sweden. He received the 2018 and 2022 IEEE Marconi Prize Paper Awards in Wireless Communications, the 2019 EURASIP Early Career Award, the 2019 IEEE Communications Society Fred W. Ellersick Prize, the 2019 IEEE Signal Processing Magazine Best Column Award, the 2020 Pierre-Simon Laplace Early Career Technical Achievement Award, the 2020 Communication Theory Technical Committee Early Achievement Award, the 2021 IEEE Communications Society Radio Communications Committee Early Achievement Award, and the 2023 IEEE Communications Society Outstanding Paper Award. His work has also received six Best Paper Awards at conferences. He is a Fellow of IEEE, and a Digital Futures and Wallenberg Academy fellow.



Laure Blanc-Féraud (laure.blanc-feraud@univ-cotedazur.fr) received her Ph.D. degree and habilitation to conduct research in inverse problems in image processing from University Côte d’Azur in 1989 and 2000, respectively. She is a researcher with Informatique Signaux et Systèmes at Sophia Antipolis (I3S) Lab, the University Côte d’Azur, Centre national de la recherche scientifique (CNRS), Sophia Antipolis, 06900 France. She served/serves on the IEEE Biomedical Image and Signal Processing Technical Committee (2007–2015; 2019–) and has been general technical chair (2014) and general chair (2021) of the IEEE International Symposium on Biomedical Imaging. She has been an associate editor of *SIAM Imaging Science* (2013–2018) and is currently an area editor of *IEEE Signal Processing Magazine*. She headed the French national research group GDR Groupement de recherche–Information, Signal, Image et ViSion (ISIS) of CNRS on Information, Signal Image and Vision (2021–2018). Her research interests include inverse problems in image processing using partial differential equation and optimization. She is a Fellow of IEEE.



Ulisses Braga-Neto (ulisses@tamu.edu) received his Ph.D. degree in electrical and computer engineering from Johns Hopkins University in 2002. He is a professor in the Electrical and Computer Engineering Department, Texas A&M University, College Station TX 77843 USA. He is founding director of the Scientific Machine Learning Lab at the Texas A&M Institute of Data Science. He is an associate editor of *IEEE Signal Processing Magazine* and a former elected member of the IEEE Signal Processing Society Machine Learning for Signal Processing Technical Committee and the IEEE Biomedical Imaging and Signal Processing Technical Committee. He has published two textbooks and more than 150 peer-reviewed journal articles and

conference papers. He received the 2009 National Science Foundation CAREER Award. His research focuses on machine learning and statistical signal processing. He is a Senior Member of IEEE.



Behnaz Ghoraani (bghoraani@fau.edu) received her Ph.D. from the Department of Electrical and Computer Engineering,

Ryerson University, Toronto, Canada, followed by a Postdoctoral Fellow period with the Faculty of Medicine, University of Toronto, Toronto, Canada. She is an associate professor of electrical engineering and computer science at Florida Atlantic University, Boca Raton FL 33431 USA, with a specialization in biomedical signal analysis, machine learning, wearable and assistive devices for rehabilitation, and remote home monitoring. She is an associate editor of *IEEE Journal of Biomedical and Health Informatics* and *BioMedical Engineering OnLine Journal*. Her research has received recognition through multiple best paper awards and the Gordon K. Moe Young Investigator Award. Her research has been funded by grants from the National Institutes of Health, the National Science Foundation (including a CAREER Award), and the Florida Department of Health. She is an esteemed member of the Board of Scientific Counselors of National Library of Medicine, as well as the IEEE SPS Biomedical Signal and Image Professional Technical Committee. She has also taken on the role of the IEEE Women in Signal Processing Committee Chair and an Area Editor for the IEEE SPM eNewsletter.



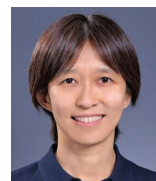
Christian Jutten (christian.jutten@grenoble-inp.fr) received his Ph.D. and Doctor es Sciences degrees from Grenoble Polytechnic Institute, France, in 1981 and 1987, respectively. He was an associate professor (1982–1989) and a professor (1989–2019), and has been a professor emeritus since Sep-

tember 2019 at University Grenoble Alpes, Saint-Martin-d'Hères 38400. He was an organizer or program chair of many international conferences, including the first Independent Component Analysis Conference in 1999 (ICA'99) and the 2009 IEEE International Workshop on Machine Learning for Signal Processing. He was the technical program cochair of ICASSP 2020. Since 2021, he has been editor-in-chief of *IEEE Signal Processing Magazine*. Since the 1980s, his research interests have been in machine learning and source separation, including theory and applications (brain and hyperspectral imaging, chemical sensing, and speech). He is a Fellow of IEEE and a fellow of the European Association for Signal Processing.



Alle-Jan Van Der Veen (a.j.vanderveen@tudelft.nl) received his Ph.D. in system theory at the Circuits and Sys-

tems Group, Department of Electrical Engineering, TU Delft, The Netherlands, with a postdoctoral research position at Stanford University, USA. He is a professor and chair of the Signal Processing Systems group at Delft University of Technology, Delft, 2628, The Netherlands. He was editor-in-chief of *IEEE Transactions on Signal Processing* and *IEEE Signal Processing Letters*. He was an elected member of the IEEE Signal Processing Society (SPS) Board of Governors. He was chair of the IEEE SPS Fellow Reference Committee, chair of the IEEE SPS Signal Processing for Communications Technical Committee, and technical cochair of ICASSP 2011 (Prague). He is currently the IEEE SPS vice president of technical directions (2022–2024). His research interests are in the areas of array signal processing and signal processing for communication, with applications to radio astronomy and sensor network localization. He is a Fellow of IEEE and a fellow of the European Association for Signal Processing.



Hong Vicky Zhao (vzhao@tsinghua.edu.cn) received her Ph.D. degree in electrical engineering from the University of Maryland,

College Park, in 2004. Since May 2016, she has been an associate professor with the Department of Automation, Tsinghua University, Beijing, 100084, China. She received the IEEE Signal Processing Society 2008 Young Author Best Paper Award. She is the coauthor of “Multimedia Fingerprinting Forensics for Traitor Tracing” (Hindawi, 2005), “Behavior Dynamics in Media-Sharing Social Networks” (Cambridge University Press, 2011), and “Behavior and Evolutionary Dynamics in Crowd Networks” (Springer, 2020). She was a member of the IEEE Signal Processing Society Information Forensics and Security Technical Committee and the Multimedia Signal Processing Technical Committee. She is the senior area editor, area editor, and associate editor of *IEEE Signal Processing Letters*, *IEEE Signal Processing Magazine*, *IEEE Transactions on Information Forensics and Security*, and *IEEE Open Journal of Signal Processing*. Her research interests include media-sharing social networks, information security and forensics, digital communications, and signal processing.



Xiaoxing Zhu (xiaoxiang.zhu@tum.de) received her Dr.-Ing. degree and her “Habilitation” in signal processing from the

Technical University of Munich (TUM), in 2011 and 2013, respectively. She is the chair professor for data science in Earth observation at TUM, Munich, 80333, Germany. She was founding head of the “EO Data Science” Department at the Remote Sensing Technology Institute, German Aerospace Center. Since October 2020, she has served as a director of the TUM Munich Data Science Institute. She is currently a visiting artificial intelligence professor at the European Space Agency’s Phi Lab. Her research interests include remote sensing and Earth observation, signal processing, machine

learning, and data science, with their applications to tackling societal grand challenges, e.g., global urbanization, the United Nations' sustainable development goals, and climate change. She is a Fellow of IEEE.

Appendix: Related articles

[A1] G. Richard, P. Smaragdis, S. Gannot, P. A. Naylor, S. Makino, W. Kellermann, and A. Sugiyama, "Audio signal processing in the 21st century," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 12–26, Jul. 2023, doi: 10.1109/MSP.2023.3276171.

[A2] D. Yu et al., "Twenty-five years of evolution in speech and language processing," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 27–39, Jul. 2023, doi: 10.1109/MSP.2023.3266155.

[A3] W. C. Karl, J. E. Fowler, C. A. Bouman, M. Çetin, B. Wohlberg, and J. C. Ye, "The foundations of computational imaging," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 40–53, Jul. 2023, doi: 10.1109/MSP.2023.3274328.


[A4] X. Li, W. Dong, J. Wu, L. Li, and G. Shi, "Superresolution image reconstruction," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 54–66, Jul. 2023, doi: 10.1109/MSP.2023.3271438.

[A5] M. Barni et al., "Information forensics and security," *IEEE Signal Process. Mag.*, vol. 40, no. 5,

pp. 67–79, Jul. 2023, doi: 10.1109/MSP.2023.3275319.

[A6] L. Wu, A. Liu, R. K. Ward, Z. J. Wang, and X. Chen, "Signal processing for brain–computer interfaces," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 80–91, Jul. 2023, doi: 10.1109/MSP.2023.3278074.

[A7] S. Vlaski, S. Kar, A. H. Sayed, and J. M. F. Moura, "Networked signal and information processing," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 92–105, Jul. 2023, doi: 10.1109/MSP.2023.3267896.

[A8] F. Liu, L. Zheng, Y. Cui, C. Masouros, A. P. Petropulu, H. Griffiths, and Y. C. Eldar, "Seventy years of radar and communications," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 106–121, Jul. 2023, doi: 10.1109/MSP.2023.3272881. 

FROM THE EDITOR *(continued from page 6)*

plenary talk, Andrea Goldsmith emphasized two important future developments. First, that SP will play an outsized role in next-generation wireless technologies. And second, that machine learning can be viewed as a tool in the SP toolbox, while knowledge about the application and the data can lead to more effective and explainable machine learning algorithms for wireless communications. Richard Baraniuk's talk, "The Local Geometry of Deep Learning," discussed a new way to view the geometry of deep learning through the lens of approximation theory via splines. This approach provides a window to the inner workings of those algorithms. Michael Jordan provided the keynote talk, "An Alternative View on AI: Collaborative Learning, Incentives, and Social Welfare," sharing his view of a future AI that is more collective and autonomous, with particular attention on statistical inference, such as prediction-powered inference, for computing valid confidence intervals.

The IEEE Historical Center exhibited photographs of pioneers and early contributions in SP at the 75th anniversary lounge (Figure 5).

In this issue

The second part of this *SPM* special issue on the SPS 75th anniversary includes eight articles that will help readers appreciate the diversity of SP, including how its expansion is impacted by technological progress, especially in microelectronics and computer science, and on many application domains that impact our everyday lives. The contents of these articles are presented in more detail in the "From the Guest Editors" column [A1]. Here is a summary of the key factors that illustrate the evolution of SP, with the emergence of new domains and technologies that have touched all aspects of our lives.

- Audio, speech, and language processing, and radar, and communications have a long history, which began before the term *SP* appeared, but they continued to evolve quite dramatically with technological innovations and societal needs becoming increasingly synergistic.
- Major technological advancements such as computer technologies, the cloud and the Internet of Things have recently spawned new SP domains, such as computational imaging, superresolution image

reconstruction, information forensics and security, and networked information.

- Brain–computer interfaces, a concept introduced by Vidal in 1973 [3], required both technological and SP advances, illustrating that complex technologies impact human health and also come with complex ethical issues related to the development of science.

We finish this editorial with the help of Constantinides, who concluded his talk with the message, "Keep calm and carry on. The future is yours."

Appendix: Related article

[A1] R. C. Guido, "IEEE Signal Processing Society: Celebrating 75 years of remarkable achievements (Part 2)," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 8–11, Jul. 2023, doi: 10.1109/MSP.2023.3285483.

References

- [1] A. Petropulu, J. M. F. Moura, R. K. Ward, and T. Argiropoulos, "Empowering the growth of signal processing: The evolution of the IEEE Signal Processing Society," *IEEE Signal Process. Mag.*, vol. 40, no. 4, pp. 14–22, Jun. 2023, doi: 10.1109/MSP.2023.3262905.
- [2] A. Oppenheim and R. Schaffer, *Digital Signal Processing*. London: Pearson, 1975.
- [3] J. Vidal, "Toward direct brain–computer communication," *Annu. Rev. Biophys. Bioengineering*, vol. 2, no. 1, pp. 157–180, 1973, doi: 10.1146/annurev.bb.02.060173.001105.

