In this issue of *IEEE Control Systems*, we speak with Giulia Giordano, an assistant professor at the University of Trento, Italy, and Tamer Başar, who is currently a Swanlund Endowed Chair Emeritus and the Center for Advanced Study (CAS) professor emeritus of electrical and computer engineering as well as a research professor at the Coordinated Science Laboratory (CSL) and Information Trust Institute (ITI) at the University of Illinois Urbana-Champaign.

Giulia Giordano received the B.Sc. and M.Sc. degrees in electrical engineering and the Ph.D. degree in systems and control theory from the University of Udine, Italy, in 2010, 2012, and 2016, respectively. She visited the California Institute of Technology in 2012 and the University of Stuttgart, Germany, in 2015. From 2016 to 2017, she was a research fellow at Lund University, Sweden. From 2017 to 2019, she was an assistant professor at the Delft University of Technology, The Netherlands, where she holds a visiting professor position. She serves as an associate editor of *IEEE Control Systems Letters* and chair of the IEEE Control Systems Society (CSS) Student Activities Committee. She has served on the program committee of various conferences. She is the author of more than 90 journal and proceedings articles and book chapters. She was recognized with the Outstanding Reviewer letter from *IEEE Transactions on Automatic Control* in 2016 and from *Annals of Internal Medicine* in 2020. She received the European Embedded Control Institute Ph.D. Award in 2016 for her thesis titled "Structural Analysis and Control of Dynamical Networks," the Nonlinear Analysis: Hybrid Systems Best Paper Prize in 2017 as a coauthor of "A Switched System Approach to Dynamic Race Modeling," and the SIAM Activity Group on Control and Systems Theory Prize in 2021. Her main research interests include the study of dynamical networks, the analysis of biological systems, and the control of networked systems.

Tamer Başar received the B.S.E.E. degree from Robert College (now Boğaziçi University), Istanbul, in 1969 and the M.S., M.Phil., and Ph.D. degrees from Yale University between 1970 and 1972. After receiving his Ph.D., he joined Harvard University as a research fellow from 1972 to 1973. He then joined the Marmara Research Center in Gebze, Turkey, where he worked as a senior research scientist from 1973 to 1980, before moving to the University of Illinois at Urbana-Champaign in 1981. Since then (in addition to being a faculty member in the Department of Electrical and Computer Engineering), he has also been a research faculty member at the CSL. In later years, he also served in the research faculty at the ITI and the affiliated faculty in the Department of Mechanical Science and Engineering. He has held key administrative positions, including interim director of the Beckman Institute (2008–2010), interim dean of engineering (2018), and director of the CAS (2014–2020). He spent sabbatical years at the Twente University of Technology, The Netherlands (1978–1979) and INRIA at Sophia Antipolis (1987–1988 and 1994–1995). He has authored approximately 1000 publications in systems, control, communications, networks, and dynamic games, including books on noncooperative dynamic game theory, robust control, network security, wireless and communication networks, and stochastic networked control. He is a member of the U.S. National Academy of Engineering and a Fellow of IEEE, the International Federation of Automatic Control (IFAC), and the Society for Industrial and Applied Mathematics. He has received several awards and recognitions over the years, including the Hendrik W. Bode Lecture Prize (CSS), the Giorgio Quazza Medal (IFAC), the Richard E. Bellman Control Heritage Award of the American Automatic Control Council (AACC), the Isaacs Award of the International Society of Dynamic Games (ISDG), the IEEE Control Systems Award, the Wilbur Lucius Cross Medal of Yale University, and several international honorary doctorates and professorships. He has served as the president of the ISDG (1990–1994), the CSS (2000), and the AACC (2010–2011) and as the editor-in-chief of *Automatica* (2004–2014). He currently is the editor of several book series. His current research interests include stochastic teams, games and networks, multiagent systems and learning, data-driven distributed optimization, modeling and control of the spread of pandemics and disinformation, security and trust, energy systems, and cyberphysical systems.

Rodolphe Sepulchre

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GIULIA GIORDANO

Q. How did your education and early career lead to your initial and continuing interest in the control field?

***Giulia*:** It was not a straightforward path. I have always been torn between my love of literature, music, and art as well as my love of philosophy, mathematics, and science. When I was 11, in a school essay asking to "pick the character in Homer's poems that you feel closer to, and explain why," I enthusiastically chose Ulysses. I wanted to explore and know more about the world, beyond any limit. I was thinking about Dante's *Inferno*, where Ulysses urges his sailors to cross the Pillars of Hercules: *fatti non foste a viver come bruti, ma per seguir virtute e canoscenza* (you were not made to live as brutes, but to follow virtue and knowledge). Already then, although I dreamed of also becoming a novelist, I pursued research as a job—the specific field was still to be determined. However, I was fascinated by the beauty of research: enjoying complete freedom and, at the same time, upholding deep moral and intellectual rigor, being independent, and having the possibility to team up with extraordinary people driven by passion and curiosity.

It was not easy to choose a subject to focus on at the university. Eventually, I rolled the dice. Within the electrical engineering curriculum, I was soon fascinated by systems and control theory because it is naturally well suited to build bridges between different disciplines and explain phenomena in the most diverse contexts. It is a mathematically rigorous approach to explore and understand the world, ranging from engineering devices to nature and living beings, including efforts to improve it. Reading through the books and papers by Sergio Rinaldi revealed to me that systems and control could have something to say, even about human creativity and the plots of novels: I had found "one ring to rule them all," and I wanted it on my finger!

Both my B.Sc. and M.Sc. theses dealt with systems and control, under the guidance of Franco Blanchini. The former was about the equalized filtering of discrete-time processes. In the latter, I started to tackle the structural analysis of biological systems (a topic that I have continued to cherish and develop for many years). I am grateful to Franco for being such an enthusiastic mentor and friend since then. His expertise, insight, creativity, and genuine and contagious zeal for research set an example for me.

Right before getting my M.Sc. degree, I had the opportunity to spend the summer doing research at Caltech, hosted by Richard Murray and also mentored by Elisa Franco. They taught me a lot as well, and being able to learn from various mentors (each with his/her own style and viewpoints) in diverse environments was extremely valuable. Elisa introduced me to the fascinating world of biology (we worked on biomolecular rate-regulator circuits), laying the foundations for a long-lasting friendship and collaboration. After meeting a lot of "people in control" and seeing the world of research from several different perspectives, I was happy to join the community.

Even though my research interests are multifaceted and strongly interdisciplinary, systems and control methodologies remain at the heart of my work because of their ability to connect and provide insight into phenomena in many different fields. My continuing interest in the control field is kept aglow thanks to all of the wonderful people who are part of the community and with whom I have had the privilege to work and interact during all these years.

Q. What are some of your research interests?

***Giulia*:** My main body of research revolves around the analysis and control of dynamical networks. Although I appreciate elegant mathematical results in themselves, I am particularly fascinated by interdisciplinary research challenges at the intersection between engineering and life sciences, where mathematics is precious as a powerful common language to describe and understand phenomena.

I am especially interested in approaches for structural analysis that are aimed at revealing qualitative properties

Giulia Giordano (right) with Elisa Franco in Washington, D.C., for the 2013 American Control Conference.

of networked dynamical systems that exclusively depend on their inherent interconnection structure and are independent of parameter values (which are often deeply uncertain). For instance, biological networks can preserve fundamental behaviors and properties that are crucial for survival, despite huge uncertainties, variations, and fluctuations. Structural analysis can provide insight into the sources of their extraordinary robustness. I find it particularly exciting to investigate nature through the lens of systems and control theory, to unravel the intrinsic functioning of biological systems. However, structural approaches can also help us synthesize biomolecular systems that are guaranteed to exhibit a desired behavior (even in highly uncertain environments) or suggest adopting the same clever strategies selected by nature in the design of bioinspired robust engineering systems. I believe it is fundamental to establish a virtuous circle between nature and engineering. Learn from nature, and, at the same time, carefully and wisely engineer nature to improve our wellbeing and quality of life, while protecting and respecting the environment. Systems and control approaches can help us achieve this goal.

I am developing a growing interest in opinion dynamics as well as in the analysis of ecological systems to foster more efficient and sustainable approaches in agriculture. Moreover, the COVID-19 pandemic has unexpectedly shaped my research activities toward the study of epidemiological systems. This unprecedented situation of danger and concern prompted me to use the tools of our discipline to better understand what was going on, predict what could happen, and realize what could be done. Thanks to a nice interdisciplinary collaboration, these efforts soon became research work. The recent health emergency has reminded us of the importance of mathematics to model, understand, predict, and control the contagion of infectious diseases. I am happy to have given my small contribution to this huge endeavor.

Q. What courses do you teach relating to control? Do you have a favorite course? How would you describe your teaching style?

***Giulia*:** During the years, I have taught graduate courses on systems and control theory, network dynamics, robust and multivariable control, and systems biology. I prefer courses with few attendees, which allow for more personal interaction and lively lectures. Within the elective M.Sc. course I just taught in Trento, I organized a Student Seminar Series. Each student freely chose a topic beyond the course program, studied it autonomously (with my support and guidance), and gave a 1-h seminar followed by feedback, questions, and interactions. The

(From left) Paul Van den Hof, Franco Blanchini, Giulia Giordano, and Alison Waldron at the International Federation of Automatic Control World Congress 2017 Award Ceremony in Toulouse, France. (© Lilie Pinot; used with permission.)

students loved this opportunity to challenge themselves and finally be on stage, instead of passively taking notes while the professor speaks.

I hope to teach my students that the motto of real science is not *ipse dixit*, but *nullius in verba*: a statement is authoritative when it is profound and true, regardless of the speaker's status. While acknowledging that we all owe a lot to the legacy of great thinkers, I encourage my students to dare to be free spirits and always think with their own minds. I hope to earn their trust and esteem day after day, exactly as my teachers and mentors have gained my own trust and esteem by setting an example of knowledge, rigor, intellectual honesty, and enthusiasm.

My lectures try to balance generality and meaningful examples, and I aim for the students to always grasp the essence and deep conceptual meaning, even when it might be hidden by technicalities and little details. I also like to stress the far-reaching interdisciplinary nature of our field. In addition to stuffing students with new notions, I wish to help them develop their own personality. I like them to be active and engaged in the classroom, and I try to follow Socrates' maieutic method to stimulate critical thinking and prompt my students to find new routes to the solution of problems.

Q. What are some of the most promising opportunities you see in the control field?

***Giulia*:** Control is already pervasive and ubiquitous across engineering, although it is often invisible—the "hidden technology," according to Karl Johan Åström's brilliant definition—and it is already mature. There is surely a margin for improvement. However, it seems increasingly hard to develop new theory strictly within the control field. I believe our field has huge potential when reaching out to other fields and the broader scientific community. This mission requires efforts to understand other jargons and make our own findings intelligible and widely accessible, which is particularly exciting. Systems and control theory was born to be interdisciplinary. Think of Ludwig von Bertalanffy and Norbert Wiener. Many promising opportunities arise if we keep the same spirit. Our community has developed powerful methods, tools, and concepts, and our mathematics can be used as a language that enables a deeper understanding across fields. From environmental sciences to biology, from nanoscience to neurosciences and why not economy, history, and geopolitics? A whole world is waiting for us to explore it with our methodologies! Also, the challenges arising from applications in a wide span of diverse fields could stimulate completely new theory.

Q. What are some of your interests and activities outside of your professional career?

***Giulia*:** I really struggle to find enough time for all I care about. I have always had a deep love for the humanities. I am fond of literature and poetry, fine arts, history, and philosophy. As a teenager, I was selected to represent Italy at the XIV International Philosophy Olympiad, and I am still attracted to speculation, debate, and philosophical thinking. My greatest passion is writing poems and, above all, historical novels with at least one mysterious murder in them. I can merge my love for literature, the fascinating atmospheres of the past, and research and investigation. Building the plot of a crime novel is akin to proving a theorem—the main difference is that the statement must come as a surprise at the end! I love singing, and I have fun playing—or, I should say, learning to play—the flute/recorder and

Giulia Giordano exploring Tasmania after the 2017 IEEE Conference on Decision and Control in Melbourne, Australia.

Profile of Giulia Giordano

- *Current position*: assistant professor, University of Trento, Italy.
- *Visiting and research positions*: Delft University of Technology, The Netherlands (currently visiting professor); Lund University, Sweden; University of Stuttgart, Germany; University of Udine, Italy; California Institute of Technology.
- *Contact information*: University of Trento, Via Sommarive, 9, Povo, Trento, 38123, Italy, giulia.giordano@unitn.it, http://giuliagiordano.dii.unitn.it/.
- *IEEE Control Systems Society experience highlights*: chair, Student Activities Committee (2020–present); associate editor, *IEEE Control Systems Letters*, (2020–present), Electronic Information, IEEE Life Science Technical Community, (2019–present).
- *Notable awards*: IEEE Transactions on Automatic Control Outstanding Reviewer letter (2016); European Embedded Control Institute European Systems and Control Ph.D. Award (2016); Nonlinear Analysis: Hybrid Systems Best Paper Prize (2017); Annals of Internal Medicine Outstanding Reviewer letter (2020); SIAM Activity Group on Control and Systems Theory Prize (2021).

the clarinet. I am fond of music, especially classical and opera, as well as theater.

I am definitely not a sporty person…still, I always like having a stroll, cycling, swimming, or hiking, particularly in the mountains. I don't like physical effort, but I am up for it—if I manage—when it is needed to reach beautiful places and have access to new landscapes. That's why I like traveling to see exciting places and meet stimulating people and cultures.

Q. Thank you for your comments.

***Giulia*:** Thank you for the opportunity. It has been a pleasure.

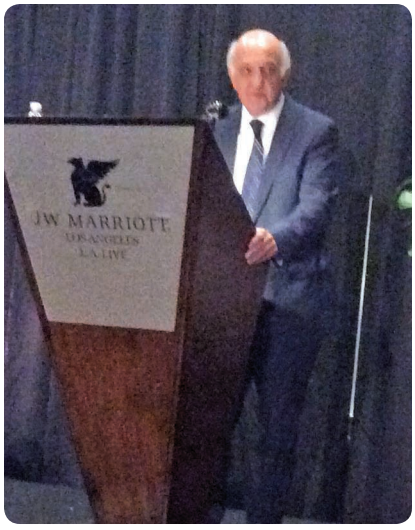
TAMER BAŞAR

Q. How did your education and early career lead to your initial and continuing interest in the control field?

***Tamer*:** What attracted me to control, from my undergraduate years, was its unique way of blending the practice of electrical engineering with the rigor of mathematical thinking and reasoning. What made me stay in control was its interdisciplinary aspect, covering the gamut of applications from engineering to economics, biology, and medicine. I should also add to that the intellectual challenge the control field brings, particularly when interpreted in a broader sense, including networks, optimization, learning, and game theory (which are now areas researchers anchored in control contribute to in masses, as we can see in leading control conferences).

Q. What are some of your research interests?

***Tamer*:** Throughout my research career, I have been interested in a diverse set of topical areas. However, if we look for an umbrella clause to encapsulate most of them, it would be "decision making under uncertainty," which could involve a single decision maker (or controller), as in stochastic control, or multiple decision makers (or agents), as in stochastic teams or stochastic games. In the former, the objectives of all agents are aligned or are common. In the latter, they are different and, in some cases, totally conflicting (as in zero-sum games). The uncertainty could come from imprecisions in modeling (as in robust control), the environment, or actions of the agents (as in multiagent reinforcement learning). The role information plays in such decision problems and how information structures affect the nature of various equilibrium solutions (their existence, uniqueness, and characterization) have been primary concerns in my research. My current research continues along that path and involves dynamic games and stochastic teams, particularly with asymmetric information; games with a high population of players, particularly mean-field games; risk-sensitive decision making; strategic information transmission and models of spread of disinformation; epidemic modeling and network-based control of its spread; multiagent systems and learning; data-driven distributed optimization; security and trust; energy systems; social networks (such as the modeling and analysis of opinion dynamics); and cyberphysical systems.



Tamer Başar delivering an acceptance speech at the 2014 IEEE Conference on Decision and Control for the IEEE Control Systems Award.

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