university to promote interdisciplinary research, contribute viewpoints on science policy and talent development, and organize inspiring activities for the public to boost the relationship between science and society. I care deeply about the diversity and internationalization in our working environment and believe that, as young researchers, we should have our own voice in the operation of the university. I have participated in organizing public workshops on data management, dual-career policies for junior researchers and their partners, and internationalization in classrooms by considering cultural differences in teaching and learning. Through this process, I have met many passionate young researchers in different fields. Interestingly, some of my research collaborations have grown out of such social interactions.

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

***Ming*:** I enjoy cycling in the forests or along rivers. The Netherlands is a flat country, and it seems to me that every Dutch person is a professional cycling athlete. Otherwise, most of my spare time is spent with my two daughters, who are in the same primary school. They actually help my wife and me get to know the Dutch culture much better. They like to spend some weekend hours in children's workshops in different museums, and my older daughter has shared with me many facts about van Gogh I never knew. After my daughters started to take tennis lessons, I began playing tennis regularly with them, which is a lot of fun. I also teach them Chinese regularly to keep them connected with their roots, as I guess most Chinese parents living abroad do.

Q. Thank you for your comments.

***Ming*:** It was my great pleasure.

Profile of Ming Cao

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- *IEEE Control Systems Society experience highlights*: associate editor, *IEEE Transactions on Automatic Control* (2016–present); member, Conference Editorial Board (2010–2017).
- *Notable awards*: International Federation of Automatic Control, Manfred Thoma medal (2017); European Control Award (2016).

RAVI N. BANAVAR

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

***Ravi*:** My early graduate education was focused on the vibration control of a flexible one-link manipulator. This led to a keen interest in the theoretical aspects of control, and I was hooked.

Q. What are some of your research interests?

***Ravi*:** I am interested in the applications of geometry in control engineering problems, in particular, differential geometric techniques applied to the control of satellites, wheeled mobile robots, and microrobots. Also, I am interested in constrained discrete optimal control on Lie groups, with applications in mechanical and aerospace engineering.

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

***Ravi*:** I have taught a spectrum of courses ranging from Linear Systems Theory, Nonlinear Control Systems, Optimal Control, Geometric Mechanics, and Differential Geometric Methods in Control. The last two are certainly my favorites, particularly teaching coordinate-free control techniques. I love drawing pictures on the board, and I

Ravi Banavar

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The field of systems and control provides a fundamental perspective and a set of tools for viewing and tackling a wide range of research problems in engineering.

believe that visualization of a problem is essential. The details of the math (although very important) follow from this. My students are the main source of my sustained academic enthusiasm.

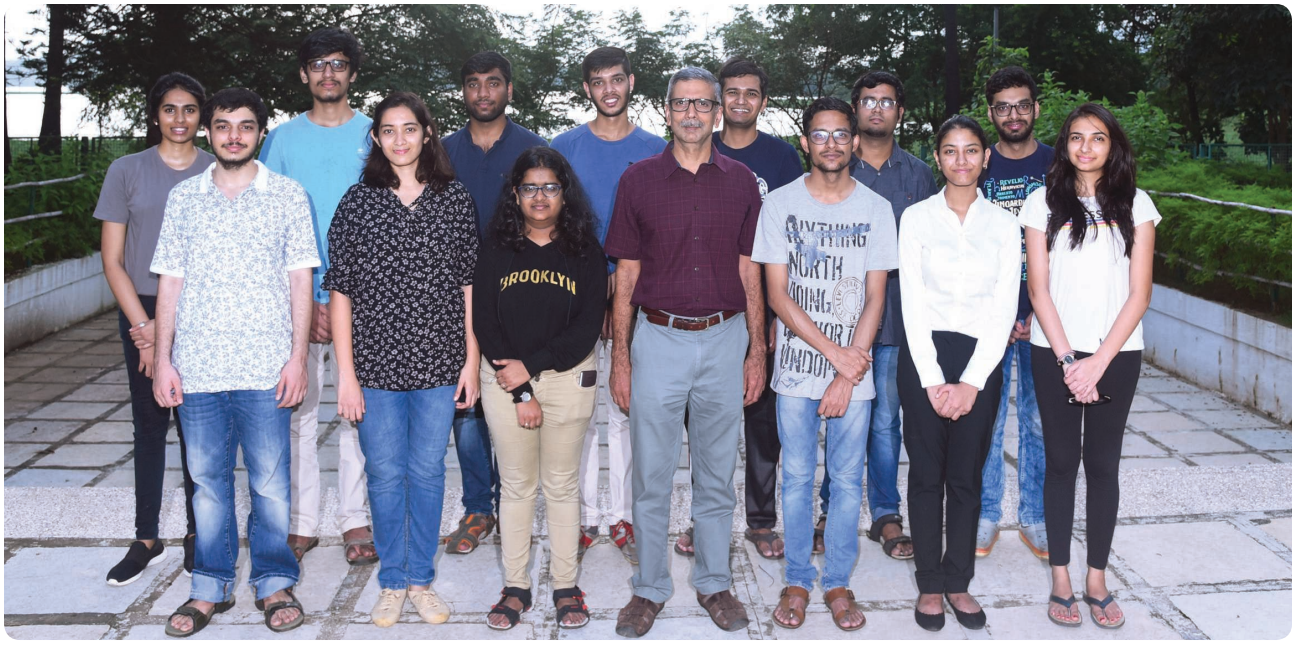
At Gulmohar Café: (from left) Ravi Banavar, Ankur Kulkarni, Srikant Sukumar, Vivek Natarajan, and Debasish Chatterjee.

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

***Ravi*:** The field of systems and control provides a fundamental perspective and a set of tools for viewing and tackling a wide range of research problems in engineering. Very few fields in applied science, I believe, offer this opportunity. This training that systems and control provides helps one master other areas of engineering research with ease. Machine learning and deep learning are the next promising fruits to be plucked for control engineers.

Q. Could you describe the Systems and Control Group at the Indian Institute of Technology (IIT) Bombay and its core philosophy?

***Ravi*:** The Systems and Control Group at IIT Bombay is a solely graduate-level academic entity, with no undergraduate program. The faculty members of the group, however, participate in the undergraduate programs of other conventional academic units, such as electrical, mechanical, and aerospace engineering. In a nutshell, the core philosophy is to impart a rigorous mathematical foundation in systems and control to our master's and doctoral students. Our goal is to graduate doctoral students who are sought after by the best academic/research institutions across the world.



Ravi Banavar (front row, center) and his group in front of Powai Lake.

Profile of Ravi N. Banavar

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Q. Could you explain the challenges faced in raising the Systems and Control Group to the current level of international repute and how you went about the task?

***Ravi*:** I took over as chair of our group (termed *convener* here) in 2009. We were at a faculty strength of four, and it was imperative that we grew and made our presence felt in the institute as well as in the international arena at large. The need of the hour was to woo and charm a few outstanding faculty candidates to apply and join us. I took up this task with great enthusiasm. Two factors helped me: the revised pay scales and the emphasis on graduate education and research that was in full force at IIT Bombay.

I was successful in enticing talented individuals, with strengths ranging from stochastic switched systems and adaptive control to game theory and control of partial differential equations, to join our group. This was my biggest achievement, and we have never looked back since. Today we are at a strength of 10, with the latest induction being in the field of quantum control.

Q. You are the author of many papers and monographs in the control field. What topics do these papers cover?

***Ravi*:** My contributions range from applications of H_∞ control to my work in the past 10 years, which has focused on differential geometric techniques and constrained discrete optimal control methodologies applied to mechanical and aerospace systems. I have also begun to investigate motion-planning algorithms for microrobots navigating in low-Reynolds-number conditions.

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

***Ravi*:** Outside engineering academics, I love music (Indian classical, western classical, folk, and Bollywood songs), literature (Oscar Wilde, Shakespeare, O. Pamuk, and W. Dalrymple), and history (Arnold Toynbee). I am also an occasional baker and passionate swimmer, and I do not miss out on this indulgence wherever I travel.

Q. Thank you for your comments.

***Ravi*:** Thank you for giving me this opportunity. My pleasure.

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Small Data and the Mind

When he was in graduate school, Tom [Griffiths], along with MIT's Josh Tenenbaum, ran an experiment asking people to make predictions for a variety of everyday quantities—such as human life spans, the grosses of movies, and the time that US representatives would spend in office—based on just one piece of information in each case: current age, money earned so far, and years served to date. Then they compared the predictions people made to the prediction given by applying Bayes's Rule to the actual real-world data across each of those domains.

As it turned out, the predictions that people had made were extremely close to those produces by Bayes's Rule. Intuitively, people made different types of predictions for quantities that followed different distributions—power-law, normal, and Erlang—in the real world. In other words, while you might not know or consciously remember which situation calls for the Multiplicative, Average, or Additive Rule, the predictions you make every day tend to *implicitly* reflect the different cases where these distributions appear in everyday life, and the different ways they behave.

In light of what we know about Bayes's Rule, this remarkably good human performance suggests something critical that helps to understand how people make predictions. *Small data is big data in disguise.* The reason we can often make good predictions from a small number of observations—or just a single one—is that our priors are so rich.

There's a crucial caveat here, however. In cases where we don't have good priors, our predictions aren't good. Good predictions require good priors.

—Brian Christian and Tom Griffiths, *Algorithms to Live By: The Computer Science of Human Decisions*, p. 144, reprint edition, Picador, April 2017, ISBN-13: 978-1250118363.