Login

DSWEB
The Dynamical Systems Web

CURRENT ISSUE   ALL ISSUES

Search...   SEARCH

Home > The Magazine > Article

Professional Feature - Guanrong Chen

By **Invited Professional Contribution**

🖨 Print

For many years, I have been reluctant to write about my academic career. This is not because my career was unmeritorious, but rather I felt that my career path may be unrelatable to many and rare for young readers to replicate or even to imagine; therefore, it didn't seem worthwhile for me to tell. Today, however, thanks to Editor Dr. Jie Sun's persistent inquiry and encouragement, I decided to briefly write it out to share with our readers.

I had a very humble beginning that most, if not all, readers did not or will not have. One might have learned in World History class about the so-called "Cultural Revolution" in China, which took place in 1966 and lasted for a decade, during which all universities were closed. At that time, I was a high-school student expecting to enter a college in the coming year. My dream was shattered, of course, as were those of the rest of a whole generation of youth in the country. I was sent to a mountain village on Hainan Island to reclaim wastelands, living in a grass hut and experiencing constant hunger. Nevertheless, I did not want to devote my life only to hard manual labor without learning new scientific knowledge.

Motivated by my strong interest in learning mathematics, and spurred by my determination not to waste my life, I lit up a small kerosene lamp every night in the hut to study. I dedicated myself to learning mathematics by myself, using some textbooks discarded by previous university students and professors. Gradually and continuously through the seven years in the mountain village, and the following three years as a porter in my hometown Guangzhou city, I completed the learning of calculus, linear algebra, ordinary differential equations and theoretical mechanics, as well as parts of probability and statistics, partial differential equations and functional analysis.

After the Cultural Revolution ended in 1976, all Chinese universities were reopened. I took and passed a stringent nationwide entrance exam in several advanced mathematical subjects, and was admitted into the postgraduate program of the Mathematics Department of Sun Yat-sen University in Guangzhou. I started to do some research on computational mathematics under the supervision of my advisor Yuesheng Li. Three years later, I gained my Master's degree and then moved on to the USA for PhD studies in the Mathematics Department of Texas A&M University, where I started new research on optimal approximation theory in control systems under the supervision of my advisor Charles K. Chui.

Continuously driven by my innate desire of making up for the loss of ten years' time, I studied day and night, on several courses in advanced applied mathematics as well as systems

More from DSWeb

- Remembering Erik M. Bollt

- Understanding Ecological Change Through Changing Population Distribution Patterns

- Professional Feature - Adilson E. Motter

- It's the End of DSWeb as We Know It

- NumbaCS: Numba Coherent Structures

engineering. There was no hurry for me to graduate, though, partially because I might have to return to China to work thereafter. Admittedly, instead of submitting my thesis earlier, I started to write with my advisor several papers and books, resulting in a textbook on optimal estimation titled *Kalman Filtering with Real-Time Applications* (Springer, 1987; 5th edition 2016) and a research monograph on optimal systems reduction titled *Discrete H^infinity Optimization* (Springer, 1989).

One day, I received a call from Rui de Figueiredo at Rice University before I defended my PhD thesis. Although we did not know each other, he asked if I would be interested in working with him as a post-doc fellow, based on his reading of a couple of my papers. I consequently became a visiting assistant professor at Rice for three years, where I started to work with Rui on nonlinear control systems, together we completed and later published a research monograph titled *Nonlinear Feedback Control Systems—An Operator Theory Approach* (Academic Press, 1993).

Figure 1. *Standing with Leon Chua in front of the Lao Tzu statue in Leon's hometown Quanzhou, China (November 13, 2013).*

Nonlinear systems are inherited with complex dynamics. Starting in the late 1980s, I gradually moved into the field of nonlinear dynamical systems—specifically chaos theory and bifurcation analysis. The chaotic Lorenz system and Chua's circuit attracted my great interests. Then, the Ott-Grebogi-Yorke perturbation method for "controlling chaos" (Phys. Rev. Lett. 64, 1196, 1990) motivated me to consider the opposite direction of control, namely, when chaos is useful such as for encryption and liquid mixing, how can one purposefully generate chaos by a simple and implementable controller? I consequently developed a systematic approach of anticontrol of chaos, or called chaotification, by means of simple feedback control. The methodology, with the assistance from my former post-doc fellow Tetsushi Ueta, led to the discovery of the so-called "Chen system" as a dual system to the classic Lorenz system. Soon after, with my former student Jinhu Lu, we also coined a chaotic system bridging the two dual chaotic systems. These were then extended to a generalized Lorenz systems family in a joined effort with my

colleague Sergej Celikovsky (https://arxiv.org/abs/2006.04066). Furthermore, with my colleague Simin Yu and also Jinhu Lu, we developed an effective methodology to generate all sorts of multi-scroll chaotic attractors from electronic circuits. For linear maps, on the other hand, in collaboration with my colleagues Dejian Lai and Yuming Shi, my anticontrol technique provides a unified way to rigorously generate chaos in the sense of Li-Yorke or in the sense of Devaney by simple feedback control (Phil. Trans. R. Soc. A 364, 2433-2447, 2006).

Figure 2. *Dining with Jim Yorke in Le Havre (June 23, 2014).*

In year 2000, I moved to City University of Hong Kong from the University of Houston, to work as a chair professor and now the Hong Kong Shun Hing Education and Charity Fund Chair Professor in Engineering, where I also founded the Research Centre for Complexity and Complex Networks. To extend the study of synchronization from two chaotic oscillators to a network of chaotic oscillators, I was one of the very first in China to notice the small-world network model (Watts and Strogatz, Nature, 393, 440-442, 1998) and scale-free network model (Barabasi and Albert, Science, 286, 509-512, 1999). I consequently led great efforts in the Chinese scientific communities to pursue a research development in complex networks and organized the first national conference in 2004, which has thereafter become an annual conference series on complex networks in China. With my colleagues Xiaofan Wang and Xiang Li, as well as Zhisheng Duan, we initiated the pinning control approach to complex network synchronization, resulting in a textbook type of monograph titled *Introduction to Complex Networks—Models, Structures and Dynamics* (Higher Education Press, Beijing, 2nd edition, 2015).

Recently, my former student Xiong Wang and I, along with other pivotal collaborators, found chaos from some first-order three-dimensional quadratic polynomial systems, which have no equilibria, or have only stable equilibria, or have infinitely many equilibria that form a curve or a surface or a subspace, summarized in our edited book (with Nikolay V. Kuznetsov) titled *Chaotic Systems with Multistability and Hidden Attractors* (Springer, 2021). This collaboration widens up a research direction on non-hyperbolic chaotic systems.

Throughout my career, I received some encouraging recognitions: I was elected IEEE Fellow in 1997 and am now Life Fellow. I was awarded the 2011 Euler Gold Medal from Russia, and conferred Honorary Doctor Degrees by the Saint Petersburg State University, Russia in 2011 and by the University of Le Havre Normandy, France in 2014. I became a Member of Academia

Europaea in 2014 and a Fellow of The World Academy of Sciences in 2015. Since 2010, I have succeeded my mentor Leon O. Chua to serve as the Editor-in-Chief for the International Journal of Bifurcation and Chaos. These are honors both bestowed and earned through sheer diligence, dedication, and dogged persistence of academic endeavors.

In retrospect, I did not wish to inherit a legacy from the ten-year deprivation of my youth marked by helplessness or lack of control over my life; instead, by relentlessly pursuing my goals, with unwavering belief in myself, and drawing on my strong discipline for self-study of new subjects and self-exploration of new research directions, I have recovered a decade of my life that was lost to the Chinese Cultural Revolution. I have since turned that loss into a personal abundance that has launched a fulfilling career and enriched an entire academic life. With this, I hope young readers could learn something meaningful from my uncommon career path to benefit their own academic pursuits.

Figure 3. *Hiking with Steve Smale in Hong Kong (October* 1*, 2015).*

Categories: Magazine, Articles

Tags:

Please login or register to post comments.