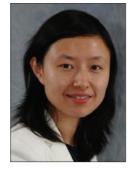
## Women in Networks: Dr. Lili Qiu

MICROSOFT RESEARCH ASIA AND UNIVERSITY OF TEXAS AT AUSTIN

ili Qiu is an assistant managing director at Microsoft Research Asia, in charge of MSRA Shanghai lab, and a professor in the Computer Science (CS) Department at the University of Texas at Austin. Her research interests are Internet and wireless networks. She received her M.S. and Ph.D. degrees in computer science from Cornell University in 1999 and 2001, respectively. After graduation, she spent 2001–2004 as a researcher in the System & Networking Group at Microsoft Research Redmond. She joined the University of Texas (UT), Austin in 2005, and has founded a vibrant research group working at UT. She is an ACM Fellow and IEEE Fellow. She is honored to



serve as the ACM SIGMOBILE Chair. She also received an NSF CAREER award, Google Faculty Research Award, and best paper awards at ACM MobiSys '18 and IEEE ICNP '17.

At the age of 18, Lili waved goodbye to her family and friends, and stepped onto a flight from Shanghai to New York City, which was her first flight in her life. "What would my life look like on the other side of the globe, where I know no one and even have trouble speaking their language well?" she asked herself. "Everything will be okay." She calmed herself down, and started to dream about her new life on the flight. After arriving on campus, she was so happy to see many friendly faces, and soon got busy with many classes. As physics was her favorite subject in high school, she chose to major in physics during her undergraduate studies. To earn living expenses, she took many types of part-time jobs on campus between classes: she worked as a bus girl at the school cafeteria, a student assistant in offices, a math tutor, and finally her dream job — a CS lab assistant.

After taking a few CS classes, she got very interested in CS and decided to pursue CS in graduate school. In graduate school, she did a summer internship every year in industry and was exposed to interesting real-world problems. At Sun Microsystems, she developed WebNFS client and NSFTool; at Bell Labs, she worked on adapting playout buffer for IP telephony and published her first INFOCOM paper; at Microsoft Research (MSR), she worked on exploring the characteristic of web traffic at MSNBC, and reported important findings and implications in her first SIGCOMM paper; at AT&T Labs, she helped design replication strategy for web traffic. These internships not only gave her invaluable industrial experience, but also brought her to many interesting places where she made life-long friends.

Upon graduation in 2001, she joined MSR Redmond. She was very fortunate to get the opportunity to work with and learn from world-class researchers at MSR. There she was also exposed to wireless research, and became fascinated by the networks that can be formed using signals traveling without boundaries. She interviewed product groups to understand their pain points in managing wireless networks, which motivated her to develop wireless diagnosis systems. Inspired by the vision of using wireless mesh networks to connect everyone to the Internet, she developed wireless interference models, diagnosis schemes, and placement algorithms for Internet gateways in mesh networks.

At MSR, she also worked with several outstanding interns and enjoyed the mentoring experience very much. Hence, she decided to move to academia a few years later to work with students on a long-term basis. Her industrial research and mentoring experience prepared her to take on new challenges in academia: she incorporated real-world problems into classroom discussion, started research collaboration with industry right away, and got an NSF CAREER in her first year. Lili has been a leader in wireless network management. She has published a series of papers on modeling and managing wireless interference. Wireless interference significantly impacts wireless performance. However, how to quantify its impact on a given network was not well understood. Even the most basic question what is the optimal capacity of a given wireless network — was open. Her seminal paper [1] established the first method for computing lower and upper bounds on the optimal wireless capacity for given traffic demands and network topology. This methodology can accommodate a variety of wireless characteristics. This work forms an important foundation on top of which many wireless

optimization models can be designed. The optimal wireless capacity also serves as an important baseline that we can use to compare practical protocols. It has been widely used throughout the research community, and is required reading in many wireless networking classes, including at Carnegie Mellon University, the University of Illinois, Urbana Champaign, and the University of Washington.

In [6], she showed how to model interference in IEEE 802.11, the most widely used wireless protocol today. IEEE 802.11 is hard to model since its scheduling is completely distributed, and there are strong interactions among different nodes. Non-pairwise interference, intricate interactions between different frames, and heterogeneous radio characteristics further complicate modeling tasks. Her model can handle all these real-world complexities: it models interference among any number of nodes, both unicast and broadcast transmissions, and homogeneous and heterogeneous traffic and radio characteristics.

In [2], she went beyond predicting performance, and developed a new model to facilitate wireless network optimization. Her model provides an accurate and compact characterization of the feasible solution space, which can then be incorporated in an optimization procedure. It also strikes a good balance between fidelity, generality, and tractability. While simple, it models realworld complexities, such as hidden terminals, non-uniform traffic, multihop flows, and non-binary interference. Using these models, she developed a series of approaches to optimize efficiency, reliability, and predictability through routing, rate adaptation, power control, network coding, channel assignment, and rate limiting.

In addition, she has developed novel techniques to optimize network performance, resilience, scalability, and energy efficiency through routing, rate adaptation, spectrum allocation, network coding, and multiple-input muluple-output. She also has designed techniques to automate diagnosis, testing, and upgrades of cellular networks, and some of these techniques have been adopted in a major cellular network.

More recently, Lili has become a leader in acoustic motion tracking research. Her paper [5] was one of the first works that enabled acoustic tracking on mobile phones. Its unique advantage was that it achieved high tracking accuracy using existing hardware. This work inspired lots of follow-up work. She also developed a number of approaches to improve the accuracy and enabled device-free tracking [5] on mobile phones. In addition, she led her team to design exciting applications. In particular, they developed the first acoustic-based follow-me drones on smartphones [4] with impressive accuracy: it maintained a specified following distance and orientation within 2-3 cm and  $1^\circ-3^\circ$  errors, respectively. Later, Lili and her students developed the first acoustic tracking strong self and background interference, deviation from the desired trajectory due to hand jitter, severe

## WOMEN IN NETWORKS



(a)

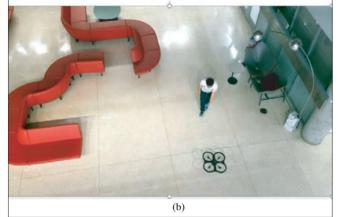


FIGURE 1. a) acoustic tracking based touchless user interface; b) acoustic-tracking-based follow-me drone.

speaker/microphone distortion, narrow beam signals, and quantization. It won the best paper award at MobiSys '18. More recently, Lili found the ability to locate human voice could open the door to many new applications, but enabling this capability presented significant new challenges since voice signals are unknown beforehand and the frequency of the human voice is low (e.g., below 5 kHz), which limits localization accuracy. She developed a novel indoor voice localization system by automatically estimating the indoor space and retracing multiple propagation paths that the user's sound traverses through the indoor space [7].

Looking back in time, Lili feels grateful for the wonderful opportunities and mentors she has had throughout her life, especially Victor Bahl and George Varghese. They are remarkable role models and mentors who have constantly inspired and supported her. Reflecting on her past, she would like to share with students:

- Seek mentors for advice and support.
- · Step out of your comfort zone and embrace new experiences.
- Be patient as good research takes time.
- Give yourselves permission to fail so that you have more courage to take risks and more energy to get up from failures.
- Take good care of yourself while working hard, as your health is the foundation of success and happiness.

## REFERENCES

- K. Jain et al., "Impact of Interference on Multi-Hop Wireless Network Performance," Proc. ACM MOBICOM, 2003.
- [2] Y. Li et al., "Predictable Performance Optimization for Wireless Networks," Proc. ACM SIGCOMM, 2018.
- [3] W. Mao, J. He, and L. Qiu. "Cat: High-Precision Acoustic Motion Tracking," Proc. MobiCom, 2016.
- [4] W. Mao et al., "Indoor Follow Me Drone," Proc. MobiSys, 2017.
- [5] W. Mao, M. Wang, and L. Qiu, "Aim: Acoustic Imaging on a Mobile," Proc. MobiSys, 2018.
- [6] L. Qiu et al., "A General Model of Wireless Interference," Proc. ACM MOBI-COM, 2007.
- [7] M. Wang, W. Sun, and L. Qiu, "Mavl: Multiresolution Analysis of Voice Localization," Proc. NSDI, 2021.