Statement of Purpose

My research interests include **computer networks, system security, mobile and ubiquitous computing, and data-intensive system design**. My fascination with these domains originate from valuable instructions and mentorship by Professor Songwu Lu and served as a companion throughout my undergraduate studies at UCLA. My further fruitful collaborations with Professors Quanquan Gu[4] in deep learning, Yizhou Sun[2] in graph mining, Fabien Scalzo[3] in medical imaging, and Deanna Needell[1] in applied mathematics further solidified my knowing that I am on a path toward becoming a top researcher who will also have the deep honor of educating groups of talented minds across the creation and build of beautiful and useful systems. In pursuing this goal, applying to the Ph.D. degree program at **MIT EECS** is the next logical step in my continued edification.

Networking research has paced into an exciting and uncharted edge computing era - traditional computer-to-server designs for node-to-node latency and throughput strongly limit the provision that every "Things" should be connected wirelessly and simultaneously. In the face of the remarkable and challenging questions in this new era, I realized research opportunities with the following major topics[1]:

Unleashing the power of shared wireless transmission channel. Wi-Fi is a shared broadcast channel ideal for multi-user gaming and video streaming. However, its multicast basic rate is limited to a 1 Mbps by legacy IEEE 802.11 standards; improvements are scant by purely hacking on this rate. Under the supervision of Prof. Songwu Lu, we designed and implemented a high rate resilient Wi-Fi multicast[7] to reach a 450 times higher physical layer rate while reducing packet loss by 20 times. Our design supports 8K resolution video streaming to all devices listening to one address simultaneously, making bandwidth-hungry multi-user applications possible. Our implementation works with Windows, Mac OS, and even Android. We are currently preparing an IETF RFC draft for this project.

Opening up blackbox design of wireless network architecture. Advancements in the network's layered design can confound end-users, application developers, and system managers. To that point, I used my $25,000 NSF Innovation-Corps grant to interview 100 industrial technical experts-developers and entrepreneurs whose foci range from autonomous vehicles to wearable sensors. The emergent and significant theme from experts interviewed relayed the idea that the problems with wireless channel, especially with Wi-Fi and LTE, are the most common but inscrutable and greatly impact their revenues. However, this wireless channel problem is not unexpected. Current Wi-Fi and LTE operate as a blackbox. Low layer information cannot be easily acquired, analyzed and availed by higher-layer applications.

On the context of the aforementioned resilient multicast, we further designed and implemented intelligent Wi-Fi[7]. Hacking Android 9 kernels, QXDM, and Wi-Fi drivers, we collected more low-layer information that renders Wi-Fi communication with the capability to perform learning via cross-layer information and reasoning through spotlighting the root causes of *what* and *why* things go wrong. On 5G/LTE, I designed a coordinated sampling algorithm for energy-efficient mobile analytics and implemented analyzers for LTE

[1]Supplementary materials such as implementation details and additional projects are on detail.keplerc.com

cross-layer information to identify packet dependencies among different LTE layers for open source software, MobileInsight[2].

Robust System Design. During my internship on detecting anomalous industrial data at Siemens Inc[6], I was so frustrated by the limitations of available deep models - high training data volume requirements and incapability to handle every scenario. As techniques such as deep learning bloom and boom in this new era, I felt an urgent need for me, with a philosophy of building *useful* and *beautiful* systems, to bridge the gap between paper designs to the true systems that can make a dent to people's lives.

Not only did I work with Prof. Songwu on system hacking, but I was so determined for the removal of the aforementioned limitations. Therefore, I knocked Professor Quanquan Gu's door and told him that I wanted to work on this project in his graduate-level machine learning course. Under his valuable guidance, I proposed, designed, and implemented an algorithm[4] to examine neural network embedding space and to eliminate samples out of training distribution[3]. I further deployed this algorithm to MobIQ Technologies in coordinating between edge and cloud servers. Edge servers, whose models are faster and smaller, can hand difficult cases over to larger models in the cloud.

After the success with Professor Quanquan, I was so exhilarated to find other opportunities to develop my ideas. One day, I played with the source code of an InfoCom paper[5], and I noticed that the state-of-the-art model, a graph convolutional network, faces a great drop when labeled training nodes are limited, thereby greatly restricting the model's practicality. With my knowledge that I could offload my research ideas to graduate class projects, I sought out the tutelage of Professor Yizhou Sun in her data mining class. I proposed, designed, and implemented a simple, yet effective fix to the stated conundrum by constructing pseudo-nodes, which thereby fascinated global information propagation[2].

As I embark upon this next phase in my journey, I am humbled to have been able to work and collaborate with such an amazing group of researchers. And through these treasured experiences, I have learned and absorbed much. I am clear in purpose. I am unwavering in direction. In this burgeoning era, every "Things" can be connected wirelessly and simultaneously. The question as to how data flow *securely* and interact *accurately* on scattered sensors, edge servers, and cloud servers remains undefined. This is this area I intend on pursuing, furthering my deep dive, beyond my background and foundational studies, instruction, and research.

I am applying to MIT for its leading position in the Internet research even before the Internet was born. The opportunity to work with the most talented people in the history of Computer Science is my greatest honor. I am open to working with a variety of professors, and I do not even mind **funding myself**. The works from **Dr. Fadel Adib**, **Dr. Dina Katabi** and **Dr. Hari Balakrishnan** especially interest me. A lot of their papers were constantly brought up by my research advisor and their existing projects align with my technology stack and past experiences. It is their footprints I hope to walk alongside in the future, buttressed by a Ph.D. education from MIT to maximize my capability to build useful and elegant systems and make real-world impacts.

[2] www.mobileinsight.net

[3] A handwriting digit classifier can never classify a cat image correctly

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