Kaiyu Hou

Curriculum Vitae

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I am currently a 4th year Ph.D. candidate in the Computer Science Department at Northwestern University, advised by Prof. Yan Chen. I have a broad interest in various aspects of cloud networks and network protocols. My current research focuses on network optimization of microservices/serverless based cloud. I am also working for introducing formal methods into network protocol verification.

Education

- **Ph.D. Student** in **Computer Science** 2017 – (2022)
  Northwestern University Evanston, IL
  - Advisor: Prof. Yan Chen
  - Area: Networked System, Cloud Networking
  - GPA: 3.97/4.0

- **Master's** in **Computer Science** 2014 – 2017
  Xi'an Jiaotong University Shaanxi, China
  - Advisor: Prof. Chengchen Hu
  - Area: Software Defined Networking (SDN)
  - Rank: 1st/89 GPA: 3.81/4.0 Average: 91.7

- **B.E.** in **Software Engineering** 2010 – 2014
  Xi'an Jiaotong University Shaanxi, China
  - Rank: 1st/78 GPA: 3.94/4.0 Average: 92.4 (in Junior and Senior years)

Work Experiences

- **SRI International** Menlo Park, CA
  Research Intern, at Computer Science Laboratory Jun. 2020 – Sep. 2020
  - Advisor: Dr. Vinod Yegneswaran
  - Designed and implemented an enterprise-wide radio situational awareness system
  - Passively collected radio traffics, including Wi-Fi and Bluetooth, analyzed by deep learning

Research: Cloud Networks & SDN

- **Network Optimizing for Microservices/Serverless Cloud** (work in progress) 2020 – Present
  - Microservices/serverless architectures bring flexibility but introduce network communication delay
  - Designed systematic metrics to provide a benchmark for the microservices network performance
  - Integrated QUIC into **OpenFaaS/Kubernetes** to improve serverless network performance

- **Generic Security Policy Enforcement System for SDN-based Cloud** 2017 – 2018
  - Designed a **policy language** for resource protection and management of SDN-based Cloud
  - Implemented in the **OpenDaylight** controller, and deployed on **OpenStack**

  Publication: *[IWQoS'18] Lightweight Resource Protection and Management System for SDN-based Cloud*

- **Routing Policy for Solving Reactive Model Overhead of Software Defined Networks** 2016 – 2017
  - Proposed a routing policy to reduce the control channel bandwidth consumption up to 80%
  - Implemented in the **Floodlight** controller under the **OpenFlow** protocol with **Open vSwitch**
  - Deployed on the ONetSwitch, an OpenFlow white-box switch with Xilinx FPGA

  Publication: *[ICNP'17] SoftRing: Taming the Reactive Model for Software Defined Networks*

Research: Formal Methods for Network Protocols

- **Formal Verification and Vulnerability Detection of LTE/5G Protocols** 2019 - 2020
  - Used **TLA+** to formally specify the emergency call systems in **4G/5G** cellular network protocols
  - Built a **complete cellular network testbed** (USRP, OpenAirInterface) for real-world verification
  - Discovered serious availability and security issues in real-world, **acknowledged by major carriers**

  Publication: *[Under Review] Discovering Emergency Call Pitfalls for Cellular Networks with Formal Methods*

- **Formal Secure Configuration Search for Network Protocols** (work in progress) 2020 - Present
  - Traditionally, researchers use secure properties to verify a protocol is safe or find counterexamples
  - We convert this decision problem into a search problem. Given the model and the properties, we aim to search the boundaries of the configuration space where the system is always secure and reliable
  - We employ inductive generalization and improved IC3 algorithm to determine the space

  Publication: *[Sigcomm'20 Poster] Network Protocol Safe Configuration Search in One Shot*

Publication List

- ***Discovering Emergency Call Pitfalls for Cellular Networks with Formal Methods***
  Kaiyu Hou*, You Li*, Yinbo Yu, Yan Chen, Hai Zhou (*equal contribution)
  Under Review
- ***Network Protocol Safe Configuration Search in One Shot***
  You Li*, **Kaiyu Hou***, Hai Zhou, Yan Chen (*equal contribution)
  ACM Special Interest Group on Data Communication (SIGCOMM, Poster), 2020
- ***State of the Art and Research Challenges in the Security Technologies of Network Function Virtualization***
  Xiaochun Wu, **Kaiyu Hou**, Xue Leng, Xing Li, Yinbo Yu, Bo Wu, Yan Chen
  IEEE Internet Computing, 2020
- ***CellScope: Automatically Specifying and Verifying Cellular Network Protocols***
  Yinbo Yu, You Li, **Kaiyu Hou**, Yan Chen, Hai Zhou, Jianfeng Yang
  ACM Special Interest Group on Data Communication (SIGCOMM, Poster), 2019

- ***A Lightweight Policy Enforcement System for Resource Protection and Management in the SDN-based Cloud***
  Xue Leng, **Kaiyu Hou**, Yan Chen, Kai Bu, Libin Song, You Li
  Computer Networks, Elsevier, 2019
- ***COIN: A fast packet inspection method over compressed traffic***
  Xiuwen Sun, Hao Li, Dan Zhao, Xingxing Lu**, Kaiyu Hou**, Chengchen Hu
  Journal of Network and Computer Applications, Elsevier, 2019
- ***SDNKeeper: Lightweight Resource Protection and Management System for SDN-based Cloud***
  Xue Leng, **Kaiyu Hou**, Yan Chen, Kai Bu, Libin Song
  IEEE/ACM 26th International Symposium on Quality of Service (IWQoS), 2018
- ***SoftRing: Taming the Reactive Model for Software Defined Networks***
  Chengchen Hu, **Kaiyu Hou** (1st student author), Hao Li, Ruilong Wang, Peng Zheng, Peng Zhang, Huanzhao Wang
  IEEE 25th International Conference on Network Protocols (ICNP), 2017
- ***Towards A Fast Packet Inspection over Compressed HTTP Traffic***
  Xiuwen Sun, **Kaiyu Hou**, Hao Li, Chengchen Hu
  IEEE/ACM 25th International Symposium on Quality of Service (IWQoS), 2017

Teaching Experiences

- CS 214: Data Structure and Data Management — Winter, 2021
  Teaching Assistant, Northwestern University
- CS 214: Data Structure and Data Management — Fall, 2020
  Teaching Assistant, Northwestern University
- CS 212, Mathematical Foundations of Computer Science — Spring, 2020
  Teaching Assistant, Northwestern University
- CS 340, Introduction to Networking (**Best Teaching Assistant Award**) — Winter, 2020
  Teaching Assistant, Northwestern University
- CS 214, Data Structure and Data Management — Fall, 2019
  Teaching Assistant, Northwestern University
- EECS 343, Operating Systems — Spring, 2019
  Teaching Assistant, Northwestern University
- EECS 340, Introduction to Networking — Winter, 2019
  Assistant Lecturer, Northwestern University
- EECS 340, Introduction to Networking — Fall, 2018
  Teaching Assistant, Northwestern University
- IT 458, Information Security and Assurance — Winter, 2018
  Teaching Assistant, Northwestern University

- Computer Programming (C++) for CS Honored Class — Fall, 2016
  Teaching Assistant, Xi'an Jiaotong University

Professional Services

- Sub-reviewer of ACM CCS (2018, 2019)
- Sub-reviewer of IEEE ICDCS (2018)
- Reviewer of IEEE/ACM Transactions on Networking (ToN)

Awards

- **Bronze Medal**, ACM-ICPC Asia Regional Contest — 2012, 2013, 2014
- **Silver Medal**, ACM-ICPC China Province Contest, Chengdu — 2012, 2013
- **Meritorious Winner**, Mathematical Contest in Modeling (MCM) — 2013

Honor

- **Best Teaching Assistant Award** (*Peter and Adrienne Barris* Outstanding TA) — 2020
  Northwestern University
- **Outstanding Graduate (Cadre) Award** — 2017
  Xi'an Jiaotong University
- **Excellent Postgraduate Student Leader Award** (each year) — 2015, 2016
  Xi'an Jiaotong University
- **Outstanding Graduate Award** — 2014
  Xi'an Jiaotong University
- **Excellent Student Model Nomination** (16/13000) — 2013
  Xi'an Jiaotong University
- **Google Excellence Scholarship** — 2013
  Awarded to 3 students from each of 20 top Chinese universities
- **Excellent Student Award** (each year) — 2011, 2012, 2013
  Xi'an Jiaotong University

Social Activities

- **Student President** of the Computer Science Dept**.,** (Class 2017) — 2014 – 2017
  Xi'an Jiaotong University
- **Student Councilor**, the Student Congress of ChungYing College — 2013 - 2014
  Xi'an Jiaotong University
- **Chair**, the ACM-ICPC Club — 2012 - 2013
  Xi'an Jiaotong University

- **Science and Education Minister** of the Student Union 2011-2012
  Xi'an Jiaotong University
- **Co-Founder** & the **2nd Store Manager** of ***Bingo Cafe*** 2010-2013
  ChungYing College, Xi'an Jiaotong University

Skills

- L2/L3/L4 Protocols, 3GPP Cellular Network Protocols (NAS layer), 802.11 Protocols, QUIC Protocols
- Serverless Platforms, Microservices Networks, Cloud Networks, SDN
- Formal Methods for Network Protocols, TLA+, IC3, NuSMV
- Python, Go-lang