

# Kai Shen

63 St. George St., Toronto, ON M5S 2Z9, Canada

Email: kai.shen@mail.utoronto.ca URL: <https://www.kaishen.ca/>

## EDUCATION

---

- University of Toronto** 09/2022 - Present
- *Ph.D.* in the ECE Department (Communication Networks A+/ Quality of Service A)
- The Chinese University of Hong Kong, Shenzhen** 09/2018 - 05/2022
- *B.Eng.* in School of Data Science, with Honours, First Class
  - Major in Computer Science and Engineering
  - Core Courses: Networks(A), Cloud Computing(A), Programming Paradigms(A), Distributed Computing(A)
- University of California, Berkeley** 06/2019 - 08/2019
- Data Structures and Algorithms (CS 61BL)

## RESEARCH INTERESTS

---

Networking, Multimedia Streaming, Deep Learning, Federated Learning, Optimization

## HONORS AND AWARDS

---

- University of Toronto Fellowship, Department of ECE, UofT 2022 - 2024
- Dean's List, School of Data Science, CUHK(SZ) 2019 - 2021
- Academic Performance Scholarship, CUHK(SZ) 2020 - 2021
- Undergraduate Student Research Scholarship, CUHK(SZ) 2020 - 2022
- Bowen's Admission Scholarship, CUHK(SZ) 2018 - 2021

## PUBLICATION

---

- "Transcend: Towards Scalable and Generalizable Network Performance Estimation," under submission as the first author.
- "TrimStream: Adaptive Realtime Video Streaming in Adverse Network Conditions," under submission as the third author.
- "Construct: Towards Generalizable Network Performance Estimation with Transformer Models," under submission as the first author.
- Dayou Zhang, Hao Zhu, **Kai Shen**, Dan Wang, Fangxin Wang. "DSJA: Distributed Server-driven Joint Route Scheduling and Streaming Adaptation for Multi-Party Realtime Video Streaming," in IEEE Transactions on Mobile Computing (TMC), 2023.
- **Kai Shen**, Baochun Li. "Learning-based Network Performance Estimators: The Next Frontier for Network Simulation," in IEEE Network, Special Issue on Interplay Between Machine Learning and Networking Systems, July 2023.
- **Kai Shen**, Dayou Zhang, Zi Zhu, Lei Zhang, Fangxin Wang, Dan Wang. "SJA: Server-driven Joint Adaptation of Loss and Bitrate for Multi-Party Realtime Video Streaming," in IEEE International Conference on Computer Communications (INFOCOM), 2023.
- Dayou Zhang, **Kai Shen**<sup>1</sup>, Fangxin Wang, Dan Wang, Jiangchuan Liu. "Towards Joint Loss and Bitrate Adaptation in Realtime Video Streaming," in IEEE International Conference on Multimedia & Expo (ICME), 2022.

## RESEARCH EXPERIENCES

---

- Discrete-Event Network Simulations on Steroids** **UofT**  
*The iQua Group, supervised by Prof. Baochun Li* 11/2023 - 02/2024
- Revisited the basics of decades-old discrete-event network simulation design from the perspective of scalability.
  - Implemented a Rust-powered, process-based, and multi-threaded network simulator, DUE, with modern development advances in generators, asynchronous programming, and stackless coroutines.
  - DUE stands out for its simplicity, scalability, and extensibility, surpassing state-of-the-art discrete-event simulators and network performance estimators by 39.15x to 44.03x speedup on large-scale FatTree topologies.

---

<sup>1</sup>co-first author with equal contribution.

## Towards Scalable and Generalizable Network Performance Estimation

UofT

*The iQua Group, supervised by Prof. Baochun Li*

01/2023 - 09/2022

- Proposed a network performance estimator, CONSTRUCT, which leverages Transformer models for joint prediction of packet delay and drop rates at the port level for enhanced generality.
- Proposed and implemented TRANSCEND to further analyzing individual queues in isolation for better scalability.
- Achieved 3.55x speedup over estimators in large-scale networks, and a 25.03x speedup over network simulators.

## Video Streaming Transmission Optimization

CUHK(SZ)

*Intelligent Networking and Multimedia Laboratory, supervised by Prof. Fangxin Wang*

03/2021 - 08/2022

- Introduced a joint adaptive solution of bitrate and packet loss for real-time UDP transmission to maximize Quality of Experience(QoE) through the Proximal Policy Optimization (PPO) algorithm.
- Implemented the coupled receiver-driven control system, OPPUGNO, which achieves 3.9% to 11.6% QoE improvement through trace-driven experiments.
- Promoted the joint loss and bitrate adaptation problem in multi-party real-time video streaming services, and proposed SJA framework for server-driven overall QoE optimization through Lyapunov-based relaxation. It achieved more stable QoE for all users with 18.4% to 46.5% improvement.

## PROFESSIONAL SERVICES

---

- Reviewer of IEEE Transactions on Mobile Computing (TMC)
- Reviewer of IEEE Transactions on Network Science and Engineering (TNSE)

## TEACHING EXPERIENCE

---

- APS105 - Computer Fundamentals Winter 2024, UofT
- CSC369 - Operating Systems Fall 2023, UofT
- CSC148 - Introduction to Computer Science Winter 2023, UofT
- CSC3150 - Operating Systems Spring 2022, CUHK(SZ)

## SELECTED COURSE PROJECTS

---

**Database Performance Regression Investigation** in *Modern Web-Scale Applications* 04/2023, UofT

- Proved the prevalence of performance regression of existing database management systems. In particular, we detected a more than 10% regression with more than 97% confidence of MySQL for throughput and latency.
- Proposed case studies to find out the root cause, for example, the cache miss is the key bottleneck of MongoDB, while the increased blocking time of epollWait is the root cause of Apache Ignite from v2.7.6 to v2.14.0.

**MIPS Simulator** in *Computer Architecture*

04/2021, CUHK(SZ)

- Assembled MIPS assembly language files to generate output files composed of machine code.
- Built a C++ based program that simulates the execution of machine codes.

**N-body Simulation** in *Distributed and Parallel Computing*

12/2020, CUHK(SZ)

- Implemented a multi-version program to simulate an astronomical N-body system in two-dimensions.
- There are 5 versions based on different frameworks: sequential version, Pthread version, OpenMP version, MPI version and MPI + OpenMP version.

**Gitlet Version-control System** in *Data Structures and Algorithms*

08/2019, UCB

- Implemented a version-control system, gitlet, which mimics basic features of git. There are 5 main functionalities that gitlet supports: git commit, git checkout, git log, git branch, and git merge.

## SKILLS

---

**Programming** Rust, Python, C/C++, Git, SQL, R  
**Languages** Chinese (Native), English (Fluent, IELTS-7.0)  
**Interests** basketball, badminton, hiking