Gengrui Zhang

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RESEARCH INTERESTS

My research interests focus on the core problems in distributed systems, especially consensus algorithms and fault tolerance. My current research studies aim to develop algorithms and architectures that build up fault-tolerant, high-performance, highly scalable, and highly available distributed systems. I am especially interested in developing consensus algorithms binding efficiency and robustness under various fault-tolerant models including benign and Byzantine failures, and applying theoretical problems to real-world applications. Towards these objectives, I am also broadly interested in questions related to distributed computing theories, consistency models, blockchains, P2P systems, cloud/distributed databases, microservices, serverless computing, and systems for AI.

EDUCATION

University of Toronto — Toronto, ON, Canada
Ph.D. Candidate, Electrical & Computer Engineering — 2019 - present
Dissertation: *"Reputation-based Consensus Algorithms: Binding Efficiency and Robustness"*
Advisor: Prof. Hans-Arno Jacobsen (*IEEE Fellow*)

University of Chinese Academy of Sciences — Beijing & Shenzhen, China
Master of Applied Science, Computer Science — 2015 - 2018
Thesis: *"Digital Content Protection Using Blockchain Technologies"*
Advisor: Prof. Cheng-Zhong Xu (*IEEE Fellow*)

Hunan University (Talent Program) — Changsha, HN, China
Bachelor of Applied Science, Computer Science — 2011 - 2015
Thesis: *"Design and Implementation of GraphX Algorithms using Apache Spark"*
Advisor: Prof. Ken-Li Li

INDUSTRY EXPERIENCE

Tencent Technology Co. Ltd — Shenzhen, GD, China
Back-end System Development Engineer, Platform & Content Group (PCG) — 2018

FELLOWSHIPS & AWARDS

ECE Student Fellowship, University of Toronto — 2019 - 2022

Research Fellowship, University of Toronto — 2019 - 2022

Outstanding Student, University of Chinese Academy of Sciences — 2017

University Individual Scholarship, Hunan University 2012 - 2014

Best Paper Award

- The 13th International Conference on Green, Pervasive and Cloud Computing 2018

Prize of Excellence, Asia SuperComputer Challenge 2014

Proud Team Award, Asia SuperComputer Challenge 2013

PUBLICATIONS

▷ Conference Papers:

- **Gengrui Zhang**, Fei Pan, Sofia Tijanic, and Hans-Arno Jacobsen. Prestige BFT: Making Decentralization Efficient in Distributed Ledgers using Reputation-based Byzantine Fault-Tolerant Consensus Algorithms. (*Submission under review*)
- **Gengrui Zhang**, Yunhao Mao, Shashank Motepalli, Shiquan Zhang and Hans-Arno Jacobsen. V-Guard: A Fast, Dynamic, and Versatile Permissioned Blockchain Framework for V2X Networks. (*Submission under review*)
- **Gengrui Zhang** and Hans-Arno Jacobsen. Escape to Precaution against Leader Failures. *In 2022 IEEE 42nd International Conference on Distributed Computing Systems, 2022.* **(ICDCS'22)** (*Acceptance rate:* 19.9%)
- **Gengrui Zhang** and Hans-Arno Jacobsen. Prosecutor: An Efficient BFT Consensus Algorithm with Behavior-aware Penalization against Byzantine Attacks. *In Proceedings of the 22nd International Middleware Conference, 2021.* **(Middleware'21)** (*Acceptance rate:* 25.9%)
- James Meijers, Edward Au, Yuxi Cai, Hans-Arno Jacobsen, Shashank Motepalli, Robert Sun, Andreas Veneris, **Gengrui Zhang**, and Shiquan Zhang. Blockchain for V2X: A Taxonomy of Design Use Cases and System Requirements. *In 2021 3rd Conference on Blockchain Research & Applications for Innovative Networks and Services (BRAINS). IEEE, 2021* (*Author names in alphabetical order except the first author*)
- **Gengrui Zhang** and Chengzhong Xu. An Efficient Consensus Protocol for Real-time Permissioned Blockchains under non-Byzantine Conditions. *In International Conference on Green, Pervasive, and Cloud Computing. Springer, 2018* **(Best Paper Award)**

▷ Journal Articles:

- **Gengrui Zhang** and Hans-Arno Jacobsen. Prosecutor+: An Efficient BFT Consensus Algorithm with Behavior-aware Penalization and Proactive Recovery. (*In preparation for submission*)
- **Gengrui Zhang**, Fei Pan, Michael Dang'ana, Yunhao Mao, Shashank Motepalli, Shiquan Zhang, and Hans-Arno Jacobsen. Reaching Consensus in the Byzantine Empire: A Comprehensive Review of BFT Consensus Algorithms. *arXiv preprint arXiv:2204.03181, 2022* (*Under review (submitted to ACM Computing Survey)*)
- James Meijers, Panagiotis Michalopoulos, Shashank Motepalli, **Gengrui Zhang**, Shiquan Zhang, Andreas Veneris, and Hans Arno Jacobsen. Blockchain for V2X: Applications and Architectures. *IEEE Open Journal of Vehicular Technology, 2022*

PATENTS

- **Gengrui Zhang**, Hans-Arno Jacobsen, and Sheng Sun. Method and System for Creating a Distributed Ledger of Verified Vehicle Transactions (Submission disclosure ID: 10004394). US Patent. 2022.
- **Gengrui Zhang**, Tongxin Bai, and Chengzhong Xu. A Second-hand Vehicle Transaction Method, Apparatus and System based on Blockchain Technology. CN 106897887 A[P]. 2017.

OPEN-SOURCE TOOLS AND INFRASTRUCTURE

- `Cabinet`: fast replication service with weighted consensus. `Cabinet` is a fast state machine replication protocol for cloud and distributed databases. It distributes weights to servers with performance criteria and achieves consensus with a quorum size $< f + 1$.
  (Artifact analysis work in preparation for submission.)
- `PrestigeBFT`: binding efficiency and robustness using reputation-based BFT consensus algorithms. `PrestigeBFT` establishes a reputation engine that rank server correctness according to their behavior history. https://github.com/thatisedward/prestigebft
- `V-Guard`: a permissioned blockchain platform for vehicle-to-everything (V2X) networks. `V-Guard` is the first blockchain architecture that allows consensus to be achieved in a dynamic environment with a high performance, targeting the problem that vehicles are often intermittently connected on the roads. https://github.com/vguardbc/vguardbft

INVITED TALKS

"Fairness in Byzantine Consensus"

- Macau University, Macau SAR, China, 2021.04

"Scaling Byzantine Consensus"

- Blockchain ACM SACMAT, Toronto, Canada, 2019.06

"Optimizing Consensus Algorithms for Permissioned Blockchains"

- Blockchain Week, Toronto, Canada, 2019.04

"Untangling Blockchain Consensus Protocols from Blockchain 1.0 to 2.0"

- Tencent, Shenzhen, China, 2018.04

"High-level Comparisons between Permissionless and Permissioned Blockchains"

- SIAT-CAS, Shenzhen, China, 2017.11

TEACHING EXPERIENCE

* Teaching assistantships are an integral part of the doctoral education at the University of Toronto.

▷ **Guest Lectures:**

- *"Introduction to Consensus Algorithms"*

  - **ECE1779 Introduction to Cloud Computing (*Fall*)** 2022

- *"Blockchains and Consensus Protocols"*
  - **ECE1770 Trends in Middleware: Blockchain Technology (*Winter*)** 2022

▷ **Teaching Assistantships:**

- Graduate-level courses:
  - **ECE1770 Trends in Middleware: Blockchain Technology (*Winter*)** 2022
    Head TA, University of Toronto
  - **ECE1762 Algorithms and Data Structures (*Winter*)** 2020 - 2021
    TA, University of Toronto

- Undergrad-level courses:
  - **ECE419 Distributed Systems (*Winter*)** 2019 - 2022
    Head TA, University of Toronto
  - **ECE345 Algorithms and Data Structures (*Fall*)** 2019 - 2021
    TA, University of Toronto
  - **ECE244 Programming Fundamentals (*Fall*)** 2019 - 2021
    TA, University of Toronto
  - **CSC263 Data Structures and Analysis (*Winter*)** 2021
    TA, University of Toronto
  - **CSC148 Introduction to Computer Science (*Winter*)** 2022
    TA, University of Toronto

STUDENTS MENTORED

Sofia Tijanic (University of Toronto, M.S. Student)	2021 - 2022
Yunhao Mao (University of Toronto, Ph.D. Student)	2020 - 2022
Shashank Motepalli (University of Toronto, Ph.D. Student)	2020 - 2022
Shiquan Zhang (University of Toronto, Ph.D. Student)	2020 - 2022

SUPERVISION

Co-supervised design projects (4th-year capstone):

- AI-Enabled Traffic Camera Feed Transcription 2021
  Students: Andrew Lau, Chunqiu (Steven) Xia, Robert Dermarkar
- Consensus Protocol Visualization Engine 2020
  Students: Robert Fairley, Yannan (Walter) Lin, Abhishek Patil, and Daniel Hu
  Github: https://github.com/ConsensusVisualization/protocols

- Consensus Protocol Visualization Engine 2020
  Students: Jinzhuo (Sarah) Tang, Xian (Shirley) Zhou, Yichen Wang, Yuchen Wang

REVIEW AND SERVICE

Conferences:

- ACM/IFIP International Middleware Conference (Middleware) 2019 - 2022
- International Conference on Distributed Computing Systems (ICDCS) 2019
- IEEE International Conference on Blockchain (IEEE Blockchain) 2019

Journals:

- Journal of Parallel and Distributed Computing (JDBC) 2018

REFERENCES

Prof. Hans-Arno Jacobsen
University of Toronto, Electrical & Computer Engineering
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jacobsen@eecg.toronto.edu
https://www.ece.utoronto.ca/people/jacobsen-h-a/

Prof. Baochun Li
University of Toronto, Electrical & Computer Engineering
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bli@ece.toronto.edu
https://www.ece.utoronto.ca/people/li-b/

Prof. Andreas Veneris
University of Toronto, Electrical & Computer Engineering
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