Dr. SHAWN LI ZENGXIANG (李增祥)

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EDUCATION

Ph.D **Nanyang Technological University (NTU)** Singapore 2012
Research Topic Efficient and Fault Tolerant HLA-based Simulations
Supervisor Professor Wengtong Cai, Professor Stephen John Turner

M.S. **Shanghai Jiao Tong University (SJTU)** Shanghai, China 2006
Research Topic Dynamic Binary Translation and Optimization
Supervisor Professor Haibing Guan

B.S. **Shanghai University of Electric Power (SUEP)** Shanghai, China 2003

EMPLOYMENT

08/2020-Present	**Executive Vice President**	Digital Research Institute ENN Group
04/2018-08/2020	**Group Manager**	Institute of High Performance Computing **A*STAR**
06/2012-08/2020	**Scientist**	Institute of High Performance Computing **A*STAR**
08/2010-06/2012	**Research Associate**	Parallel and Distributed Computing Centre **NTU**

Roles in Digital Research Institute ENN Group, Beijing, China (08/2020-Present)

Executive Vice President: As a vice executive president, I am leading a team of 50 researchers and engineers. We conduct impactful research on Industrial Internet, Artificial Intelligence, Collaborative Learning and Privacy-Preserving computing technologies, with a series of successful deployment for energy load forecasting, equipment predictive maintenance, heating system optimization, safety inspection and management, and etc. By Leveraging ENN Group's industry leading position and advantages on various applications and data, we establish collaborations amongst government agencies, industry companies and universities for fundamental research, interoperable Federated Learning platform testbed and ecosystem for various Industrial Internet applications with a number of participants from different backgrounds and regions.

Roles in Institute of High Performance Computing, A*STAR, Singapore (06/2012-08/2020)

Scientist and Group Manager: Led a team of 15 researchers and engineers, and supervised several Ph.D and internship students. Played the role as PI and Co-PI for several impactful research programmes and industry projects, establishing close relations with universities, government agencies and industrial companies, to work together as an avid collaborator on urban computing and transportation, smart manufacturing, precision medicine, green data center, and etc. Published dozens of high-quality papers on ACM/IEEE Transactions, Journals, and Conferences, and also serves as track/workshop chair of several reputable international conferences.

SELECTED PROJECTS（Digital Research Institute ENN Group）

ENNEW Digital Technology Research Institute is committed to the research and development on industrial digitalization and artificial intelligence technology innovation, for smart energy, supply chain, smart city, healthy lifestyle and etc. In recent years, the Institute has focused on AI application and collaborative learning for Industrial Internet, with fruitful R&D results, more than 400 invention patents applied, 10+ impactful papers published in 2022 with top conference awards, and several technical standards released.

❖ **Research on Industrial Internet AI**

Aiming at digital-intelligent transformation of ENN core business, we work on AI algorithms on multimodal data, including prediction algorithms based on time-series data, anomaly detection and fault diagnosis algorithms based on IoT sensor data, computer vision models based on camera and special imaging equipment , cognitive AI based on Bayesian networks and knowledge graphs, and system optimization algorithms based on operations research, evolutionary algorithms and reinforcement learning.

In addition, we are committed to research on cutting-edge AI technologies, including foundation model pre-training, transfer and adaptive learning, self-supervised learning, model compression and edge-cloud coordination mechanism, as well as model interpretability and trustworthy AI, which become more and more important to successful industry deployments.

❖ **Research on Collaborative Learning for Industrial Internet**

Collaborative ecosystem is the future of digital-intelligent transformation of Industrial Internet. We work on collaborative learning technology to enable participants co-create high-quality AI models. Our platform supports a variety of machine learning and deep learning collaborative learning algorithms and adaptive model aggregation strategies. Advanced AI technologies, such as knowledge distillation, transfer learning, self-supervised learning, hard data sample selection, similarity clustering, adaptive model compression, are adopted to enhance efficiency and effectiveness of collaborative learning in the presence of data, model and computing resource heterogeneity, which are very common in Industrial Internet applications.

ENNEW Collaborative Learning platform has also adopted privacy-preserving computing technologies to enable secure model aggregation and general computation amongst data assets from different entities, playing trade-off between privacy leakage risk and computational cost saving. Furthermore, participant contributions are measured fairly and efficiently, and thus well-designed incentive mechanism could encourage sharing high-value data to cultivate a sustainable intelligent ecosystem.

❖ **Application Scenarios for Industrial Internet AI**

Natural Gas Load Forecasting: Collaborative learning enables natural gas companies sharing massive consumers' data and leveraging consumers' confidential working plan in a legal compliant manner, for the purpose of creating highly accurate load forecasting AI models. Based on multi-variable time-series data, self-supervised learning is adopted to pretrain a foundational model, and thus, generate personalized models for consumers from different industry domains.

Smart and Safe City: Collaborative learning leverages valuable data from property companies, gas companies, heating companies, government agencies, in a privacy-preserving manner, to enhance city safety and create new business. For example, we can learn people's living habits and household profile to support efficient safety management, and train AI models to identify potential hazards based on large amounts of image and video contributed by multiple parties.

Equipment Predictive Maintenance: Vibration mechanism analysis algorithms and AI models are integrated to build a unified intelligent equipment management system. In order to solve the problem of scarce failure data and difficulty in cold-start of intelligent applications, we proposed a collaborative learning framework enabling heterogeneous model fusion with efficient cloud-edge coordination, to build an ecosystem with diverse participants, including different

kinds and scales of factories, equipment and sensor manufacturers and university laboratories, for the purpose of improving the overall intelligence level of the industry.

SELECTED PROJECTS （Institute of High Performance Computing A*STAR）

- **A*STAR SERC Strategic Fund: "Trusted Data Vault Phase 1" (Jan-2020 to Dec-2020)**

Co-chair of the "Trusted Data Element Circulation" project to research and integrate cutting-edge technologies such as blockchain, secure multi-party computing, and federated learning to support cross-organizational secure data sharing and privacy protection for federated learning, and explore applications in healthcare, transportation, insurance, maritime, and manufacturing industries.

Key partners : I2R, ACRC, BMRC

- **Singapore-Germany Academic-Industry (2+2) International Collaboration Grant "SuppliedTrust: A Blockchain-based governance framework for transparent, efficient and trusted supply chain of unregulated consumer products", Role: PI (Jan-2020 to Dec-2022)**

Lead the project to develop a supply chain regulatory framework that integrates blockchain and privacy-preserving computing technologies to support transparent, efficient, and trustworthy cross-organizational supply chains for individual consumer goods.

Key partners: Kimberly-Clark, Fraunhofer Association, German Association for Technical Supervision.

- **Industry project "Transparent HPC", Role: Key Member (Mar-2020 to Feb-2022)**

Bigdata Analytics and Machine learning for adaptive resource provisioning for HPC applications from precision medicine DNA computing, fluid dynamic simulations.

Key partners:A*STAR ACRC, Fujitsu

- **Scalable Analytics Platform (ModStore) for National Precision Medicine Research (Oct-2019 to Oct-2021)**

Develop a cloud-native data analytics platform to support large-scale genetic computing and medical data analytics.

Key partners:A*STAR GIS , SingHealth

Industrial Internet-of-Things Innovation (I3) Platform--Secure Platform for Trusted Collaborations work package (Oct-2018 to Oct-2021)

Responsible for the research and application of interoperability of various commercial industrial IoT platforms and the establishment of cross-organizational and upstream/downstream supply chain mutual trust cooperation mechanism based on blockchain technology.

Key partners: Rolls-Royce, AWS

- **Smart Manufacturing Joint Lab: "Knowledge-based Manufacturing (KBM) Industrial Internet of Things (IIOT) Shared Services (Feb-2018 to Dec-2020)**

Responsible for the convergence of edge, local and cloud computing IoT platforms and solutions, machine learning algorithms and cloud-native microservices for manufacturing applications.

Key partner: Rolls-Royce

- **Urban Computing and Engineering Centre of Excellence in Singapore (CoE): "The Large-scale Data Processing Research (LDP) Research" (Jun-2015 to May-2018)**

Responsible for high-speed parallel tools for large-scale city-level spatio-temporal data processing and analysis, as well as research on graph theory-based urban computing, exploring urban resource planning such as healthcare, multimodal transport connectivity, demand and arrival time forecasting, dial-a-ride and cab behavior analysis, school bus and ambulance scheduling, and other applications.

Key partners: Fujitsu and Land Transport Authority of Singapore.

- **Future Data Center Technology Research Program, Singapore Research Authority: Co-leader of the "Adaptive Integrated Resource Scheduling for Multi-User Data Centers" project (August 2012 to January 2015)**

Responsible for adaptive scheduling of virtual computing resources to support efficient parallel distributed applications and energy efficient data centers.
Key partners:A*STAR DSI, NUS

RESEARCH INTEREST

Federated Learning, Privacy-Preserving Computing,Blockchain,Self-supervised Learning, Big Data Analytics, Graph Analytics, Spatiotemporal Data Processing, Operations Research, Probability Forecasting
Industrial Internet, Parallel and Distributed Computing, Data Centre, Edge-Cloud Computing
Energy Digital-Intelligent Transformation, Smart Manufacturing, Equipment Predictive Maintenance, Intelligent Transportation and Urban Computing, Gene Precision Medicine

RECENT AWARDS

- “ENNEW Collaborative Learning” obtained China Academy of Information and Communication Technology (CAICT) "Federated Learning" Certificate 2022
- "5G+AIoT based natural gas long-distance pipeline station safety inspection innovation application", China Academy of Information and Communication Technology (CAICT) "Excellent use case of 5G application in energy industry sector" 2022
- "Collaborative Learning Bi-directional Knowledge Distillation Technology", Third Prize of ENN Group Technology Invention 2022
- Best Application Award in FL-AAAI’2022, Innovation Award in FL-IJCAI’2022, IAAI AI deployment award 2023.
- Grab AI for S.E.A Challenge “Traffic Management: Demand Prediction”, Top 10 solution out of 1200 participants, Jul-2019
- Amazon Research Grant “Blockchain and IoT Data Analytics for Fine-grained Transportation Insurance” (US$20000), Jun-2019

AI COMMITTEE & ACTIVITIES

- Vice-President of Alliance of Vice-President of Alliance of Federated Learning Industrial Ecosystem Development (FLAL)
- Privacy Preserving Computing Alliance, China Academy of Information and Communications Technology (CAICT)
- Federated Data and Federated Intelligence Committee in Chinese Association of Automation
- International International Partner, Trusted Federated Learning Research Lab, Nanyang Technological University
- IEEE Std 3652.1™-2020, “IEEE Guide for Architectural Framework and Application of Federated Machine Learning” Published
- IEEE Std 2894™, “IEEE Guide for an Architectural Framework for Explainable Artificial Intelligence” Approved
- China Communications Standards Association, "Privacy Computing Interoperability Across Platforms Part 3: Interconnection Protocols", revision in progress

SELECTED PUBLICATION （Digital Research Institute ENN Group）

Journal Papers:

1. Chengyi Yang, Jia Liu, Hao Sun, Tongzhi Li and **Zengxiang Li,** "WTDP-Shapley: Efficient and Effective Incentive Mechanism in Federated Learning for Intelligent Safety Inspection", IEEE Transactions on Big Data, IF 4.271, 2022， Accepted
2. Chi Zhang, Sotthiwat Ekant, Liangli Zhen, **Zengxiang Li**,"Augmented Multi-Party Computation for Secure Federated Learning" IEEE Transactions on Big Data,IF 4.271, 2022， Accepted
3. Renuga Kanagavelu， Qingsong Wei; **Zengxiang Li**; Haibin Zhang; Juniarto Samsudin; Yechao Yang; Rick Siow Mong Goh; Shangguang Wang，"CE-Fed: Communication Efficient Multi-party Computation Enabled Federated Learning"ARRAY 2020 Open Access
4. Weishan Zhang，Fa Yu， Xiao Wang， Xingjie Zeng， Hongwei Zhao， Zenglin Tian， Fei-Yue Wang， Hongwei Qi， **Zengxiang Li**， "R2Fed: Resilient Reinforcement Federated Learning for Industrial Applications"， IEEE Transactions on Industrial Informatics, IF 10.215, 2022， Accepted

Conference Papers:

1. Chengyi Yang, Jia Liu, Hao Sun, Tongzhi Li and **Zengxiang Li,** "WT-Shapley: Efficient and Effective Incentive Mechanism in Federated Learning for Intelligent Safety Inspection", FL-AAAI 2022， **Best Application Award**
2. Sheng Guo, **Zengxiang Li**, Hui Liu, Shubao Zhao and Cheng Hao Jin, "Personalized Federated Learning for Multi-task Fault Diagnosis of Rotating Machinery" FL-AAAI 2022
3. Lianlian Jiang, YuexuanWang, Wenyi Zheng, Chao Jin, Zengxiang Li, Sin G. Teo,"LSTMSPLIT: Effective SPLIT Learning based LSTM on Sequential Time-Series Data", FL-AAAI 2022
4. Shubao Zhao, Jia Liu, Guoliang Ma, Jie Yang, Di Liu and **Zengxiang Li**,"Cluster-driven Personalized Federated Learning for Natural Gas Load Forecasting" FL-IJCAI 2022, **Innovation Award**
5. Yuanyuan Chen, Zichen Chen, Yansong Zhao, Zelei Liu, Pengcheng Wu, Sheng Guo, Chengyi Yang, **Zengxiang Li** and Han Yu, "Efficient Training of Large-scale Industrial Fault Diagnostic Models through Federated Opportunistic Block Dropout" The 35th Annual Conference on Innovative Applications of Artificial Intelligence (IAAI-23) AI deployment award
6. Hanchi Shen, Jun Li, Kang Wei, Pengcheng Xia, Sirui Tian, Ming Ding, **Zengxiang Li,** "CluFL: Cluster-driven Weighted FL Model Aggregation Strategy", The 28th IEEE International Conference on Parallel and Distributed Systems (ICPADS 2022), Accepted

SELECTED PUBLICATION （Institute of High Performance Computing A*STAR）

Journal Papers:

1. Tien-En Tan, Ayesha Anees, Cheng Chen, Shaohua Li, Xinxing Xu, **Zengxiang Li**, Tien Yin Wong, Yong Liu, Daniel Shu Wei Ting, et, al. "Retinal Photograph-Based Deep Learning Algorithms for Myopia and a Blockchain Platform to Facilitate Artificial Intelligence Medical Research: A Retrospective Multi-Cohort Study" The Lancet Digital Health, Mar, 2021 (Editor's Pick)
2. Palina Tolmach, Yi Li, Shang-Wei Lin, Yang Liu, **Zengxiang Li** "A Survey of Smart Contract Formal Specification and Verification" Accepted by ACM Computing Surveys, Mar, 2021
3. Kanagevelu, Renuga; Wei, Qingsong; **Zengxiang, Li**; Haibin, Zhang; Samsudin, Juniarto; Yang, Yechao; Feng, Yang; Goh, Rick Siow Mong, "Decentralized Federated Learning with Two-Phase Multi-Party Computation", Transactions on Services Computing, Under Review
4. Chi Zhang Sotthiwat Ekanut; Liangli Zhen; Joey Tianyi Zhou; **Zengxiang Li**, "Augmented Multi-Party Computation for Secure Federated Learning" Knowledge-Based Systems, Under Review
5. Yang Zhao, Jun Zhao, Linshan Jiang, Rui Tan, Dusit Niyato, **Zengxiang Li**, Lingjuan Lyu, and Yingbo Liu "Privacy-Preserving Blockchain-Based Federated Learning for IoT Devices" IEEE Internet of Things Journal, 2020
6. Zhe Xiao, **Zengxiang Li**, Yechao Yang, Yauheni Pyrloh, Ekanut Sotthiwat and Rick Siow Mong Goh, "Blockchain and IoT for Insurance: A Case Study and Cyberinfrastructure Solution on Fine-grained Transportation Insurance" Transactions on Computational Social System, 2020

7. Renuga Kanagavelu, **Zengxiang Li,** Juniarto Samsudin, Shaista Hussain, Yang Yechao, Yang Feng, Goh Siow Mong, Rick, Mervyn Cheah "Federated Learning for Advanced Manufacturing Based on Industrial IoT Data Analytics" Book chapter of "The Model Factory as the key enabler for the Future of Manufacturing". Part of Book Series "Intelligent Systems Reference Library", Springer-Verlag, 2020
8. Eda Koksal Ahmed, **Zengxiang Li**, Bharadwaj Veeravalli and Shen Ren, "Reinforcement Learning enabled Genetic Algorithm for Vehicle Fleet Scheduling" Accepted by Journal of Intelligent Transportation Systems, 2020
9. Bo Yang, Shen Ren, Erika Legara, **Zengxiang Li**, Edward Ong, Louis Lin and Christophe Monterola, "Phase Transition in Taxi Dynamics and Impact of Ridesharing" Transportation Science, 2019
10. Quanqing Xu, Zhaozheng He, **Zengxiang Li,** Mingzhong Xiao, Rick Siow Mong Goh, Yongjun Li "An Effective Blockchain-based Decentralized Application for Smart Building System Management", book chapter of "Real-Time Data Analytics for Large-Scale Sensor Data", Elsevier 2019
11. **Zengxiang Li**, Shen Ren, Nan Hu, Yong Liu, Zheng Qin, Rick Siow Mong Goh, Liwen Hou, Bharadwaj Veeravalli, "Equality of Public Transit Connectivity: The Influence of MRT Services on Individual Buildings for Singapore", Transportmetrica B: Transport Dynamics, 2018
12. Yulin Wu, Wentong Cai, **Zengxiang Li**, Xiangting Hou, Wen Jun Tan, "Efficient Parallel Simulation over Large-scale Social Contact Networks", ACM Trans. on Modeling and Computer Simulation, 2018

Conference Papers:

1. Ekanut Sotthiwat, Liangli Zhen, **Zengxiang Li**, Chi Zhang, "Partially Encrypted Multi-Party Computation for Federated Learning", NEAC workshop IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGrid 2021)
2. Huafei Zhu, **Zengxiang Li,** Mervyn Cheah, Rick Siow Mong Goh, "Privacy-preserving Weighted Federated Learning within Oracle-Aided MPC Framework" arXiv:2003.07630
3. Qi Feng, Debiao He, **Zengxiang Li**, Li Li, Kim-Kwang Raymond Choo, "Practical Secure Two-Party EdDSA Signature Generation with Key Protection and Applications in Cryptocurrency" IEEE International Conference on Trust, Security and Privacy in Computing and Communications (TrustCom 2020)
4. Jun Zhao, Jing Tang, **Zengxiang Li**, Huaxiong Wang, Kwok-Yan Lam, Kaiping Xue, "An Analysis of Blockchain Consistency in Asynchronous Networks: Deriving a Neat Bound", IEEE International Conference on Distributed Computing Systems (ICDCS 2020),
5. Renuga Kanagavelu, **Zengxiang Li,** Juniarto Samsudin, Yechao Yang, Feng Yang, Rick Siow Mong Goh, Mervyn Cheah, Praewpiraya Wiwatphonthana, Khajonpong Akkarajitsakul and Shangguang Wang, "Two-Phase Multi-Party Computation Enabled Privacy-Preserving Federated Learning" IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGrid 2020)
6. **Zengxiang Li**, Chutima Kitcharoenpaisan, Phond Phunchongharnb, Yechao Yang, Rick Siow Mong Goh, and Yusen Li, "Efficient Multi-Party Computation Algorithm Design For Real-World Applications", International Workshop on Emerging Topic in Computer Science (ETCS 2019)
7. Xi Lin, Yequan Wang, Xiaokui Xiao, **Zengxiang Li** and Sourav S. Bhowmick "Path Travel Time Estimation using Attribute-related Hybrid Trajectories Network", ACM International Conference on Information and Knowledge Management (CIKM'19)
8. **Zengxiang Li**, Zhe Xiao, Quanqing Xu, Ekanut Sotthiwat, Rick Siow Mong Goh and Xueping Liang, "Blockchain and IoT Data Analytics for Fine-grained Transportation Insurance", International Workshop on Blockchain Technologies and Systems (BCTS'18) 2018 Best Paper Runner Up
9. Zhe Xiao, **Zengxiang Li,** Yong Liu, Ling Feng, Weiwen Zhang, Thanarit Lertwuthikarn and Rick Siow Mong Goh, "EMRShare: A Cross-organizational Medical Data Sharing and Management Framework Using Permissioned Blockchain", International Workshop on Blockchain Technologies and Systems (BCTS'18) 2018
10. Quanqing Xu, Zhaozheng He, **Zengxiang Li** and Mingzhong Xiao, "Building an Ethereum-based Decentralized Smart Home System", International Workshop on Blockchain Technologies and Systems (BCTS'18) 2018
11. Weiwen Zhang, Yong Liu, Long Wang, **Zengxiang Li** and Rick Siow Mong Goh, "Cost-Efficient and Latency-Aware Workflow Scheduling Policy for Container-based Systems", IEEE International Conference on Parallel and Distributed Systems (ICPADS'18) 2018

12. **Zengxiang Li,** Shen Ren, Sifei Lu, Jiachun Guo, Wentong Cai, Zheng Qin and Rick Siow Mong Goh, "Concurrent Hybrid Breadth-First-Search on Distributed PowerGraph for Skewed Graphs", IEEE International Conference on Parallel and Distributed Systems (ICPADS'18) 2018
13. Shen Ren, Bo Yang, Liye Zhang and **Zengxiang Li**, "Traffic Speed Prediction with Convolutional Neural Network Adapted for Non-linear Spatio-temporal Dynamics" ACM SIGSPATIAL International Workshop on analytics for Big Geospatial Data (BigSpatial 2018)
14. Xi Lin, Xiaokui Xiao, **Zengxiang Li**, "A Scalable Approach to Inferring Travel Time in Singapore's Metro Network using Smart Card Data" IEEE International Smart Cities Conference (ISC2 2018)
15. Yuhong Feng, Meihong Guo, Kezhong Lu and Zhong Ming (Shenzhen University, China); Haoming Zhong (Webank, China); Wentong Cai (NTU, Singapore); **Zengxiang Li** (IHPC, Singapore), "Optimize the FP-tree based Graph Edge Weight Computation on Multi-core MapReduce Clusters", IEEE International Conference on Parallel and Distributed Systems (ICPADS'17) 2017
16. Shen Ren, Lin Han, **Zengxiang Li**, Bharadwaj Veeravalli, "Spatial-temporal Traffic Speed Bands Data Analysis and Prediction", IEEE International Conference on Industrial Engineering and Engineering Management (IEEM'17) 2017 (Honorable Mention Award)
17. Sifei Lu, **Zengxiang Li**, Zhen Qin, Xulei Yang, Rick Siow Mong GOH, "A Hybrid Regression Technique for House Prices Prediction", IEEE International Conference on Industrial Engineering and Engineering Management (IEEM'17) 2017
18. **Zengxiang Li**, Bowen Zhang, Shen Ren, Yong Liu, Zheng Qin, Rick Siow Mong Goh, Mohan Gurusamy, "Performance Modelling and Cost Effective Execution for Distributed Graph Processing on Configurable VMs", International Symposium on Cluster, Cloud and Grid Computing (CCGrid'17)
19. Yulin Wu, Xiangting Hou, Wen Jun Tan, **Zengxiang Li**, Wentong Cai, "Efficient Parallel Simulation over Social Contact Network with Skewed Degree Distribution", ACM SIGSIM Conference on Principles of Advanced Discrete Simulation (PADS'17) 2017 (Best Paper Award)
20. Sibo Wang, Youze Tang, Xiaokui Xiao, Yin Yang, **Zengxiang Li,** "HubPPR: Effective Indexing for Approximate Personalized PageRank", International Conference on Very Large Data Bases (VLDB'17)