Shenglai Zeng

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RESEARCH INTEREST

I am a final-year undergraduate student at the University of Electronic Science and Technology of China. My research interests include federated learning, edge computing, and intelligent networks. I am also willing to try some new interesting directions in the future.

EDUCATION

University of Electronic Science and Technology of China   **Chengdu, China**
Yingcai Honor School/B.Sc in Computer Science and Engineering   *Sept 2019-Present*
CGPA: 4.00/4.00
Weighted Average: 93.97/100(2th among 100 students)
IELTS Score: 7.0(Listening 7.5 Reading 7.0 Writing 7.0 Speaking 6.5)
Courses taught: Mathematical Analysis, Linear Algebra, Discrete Mathematics, Random mathematics, Signal and System, Digital Design and Computer Architecture, Computer Organization, Computer Network, Database Management System, Operating System, Artificial Intelligence, Theory of Computation, Algorithm and Data Structure, Computer Fundamentals

PUBLICATIONS

- **Shenglai Zeng**, Zonghang Li, Hongfang Yu, Yihong He, Zenglin Xu, Dusit Niyato, Han Yu
  "Heterogeneous Federated Learning via Grouped Sequential-to-Parallel Training" Accepted by the 27th International Conference on Database Systems for Advanced Applications (**DASFAA-2022**).
- Jiaqi Wang*, **Shenglai Zeng***, Zewei Long, Yaqing Wang, Houping Xiao, Fenglong Ma
  "Knowledge-Enhanced Semi-Supervised Federated Learning for Aggregating Heterogeneous Lightweight Clients in IoT" (Submitted to **SDM-2023**)
- **Shenglai Zeng**, Zonghang Li, Hongfang Yu, Zhihao Zhang, Long Luo,Bo Li, Dusit Niyato *"HFedMS: Heterogeneous Federated Learning with Memorable Data Semantics in Industrial Metaverse"*(submitted to **IEEE Transaction on Cloud Computing(JCR Q1)**)

Patent

- **Shenglai Zeng**, Zonghang Li, Yihong He, Xun Zhang, Hongfang Yu, Gang Sun
  "A Hierarchical User Training Management Architecture and Training Strategy for Non-i.i.d Data" Chinese patent under verification, Pattern id:202110959654.7

RESEARCH EXPERIENCE

Intelligent Networking and Applications Research Center, UESTC   **Chengdu, China**
Research Assistant/Research on the Optimization of Federated Learning   *Sept 2020 - Present*
-Mentor: Professor Hongfang Yu and Dr.Zonghang Li
- Proposed a novel idea of Sequential-to-Parallel training in FL.
  One conference Paper accepted by DASFAA 2022(First author)
- Investigated the application of FL in Industrial Metaverse.
  One journal paper is in submission(First author).
- Designed a hierarchical FL system with novel user management architecture and training strategy.

National patent under verification(First inventor)

- Reproduced the LEAF benchmark and change the original code (TensorFlow version) to Pytorch version.
  (https://github.com/slz-ai/leaf-torch)

The Pennsylvania State University   **Pennsylvania, USA**
Online Intern/Research on Semi-supervised Federated Learning   *Jun 2021 - Present*

-Mentor: Professor Fenglong Ma

- Implemented a semi-supervised federated learning system combined with novel personalized punning and structure-aware collaborative distillation techniques.
  Paper submitted to SDM 2022(Co-First Author)
- Currently focusing on FL with different model structures.

The University of Chicago   **Chicago, USA**
Online Intern/Research on the IOT & Sensing Security   *Mar 2020 - Mar 2021*

-Mentor: Shinan Liu(PhD candidate)

- Tried to use audio data collected by microphone to reconstruct user's state of motion during recording time.
- Proposed a mathematical-physical model to explain the correlation between different sensors' responses to motion.

University of British Columbia   **Vancouver, Canada**
Summer Intern/Federated Data Evaluation with Unlearning   *Jun 2022 - Present*

-Mentor: Professor Xiaoxiao Li

- MITACS exchange program funded by CSC. (Changed to online internship due to the Covid-19)
- Try to use the concept of cooperative game to evaluate the importance of data of participating users in federated learning.
- Try to accelerate the evaluation process using federated unlearning.
- Try to solve the straggler problem in FL by evaluation-based data removing.

KEY SKILLS

Programming Language	Python, C, C++, Java,Matlab
Research Tool	Latex, Overleaf
AI Framework	Pytorch, Mxnet,Tensorflow
Network	Cisco Certified Network Associate(CCNA)

SELECTED ACADEMIC PROJECTS

Grouped Sequential-to-Parallel Training for Heterogeneous FL(FedGSP)   *Mar 2021- Oct 2021*

- Proposed a new concept of dynamic collaborative Sequential-to-Parallel (STP) training to improve FL model performance.
- Proposed a novel Inter- Cluster Grouping (ICG) method to assign FL clients to a pre-specified number of groups using the centroid equivalence theorem.
- FedGSP improves model accuracy by 3.7% on average, and reduces training time and communication overhead by more than 90%
- This work is acceptted by DASFAA-2022.(Big thanks to Dr.Zonghang Li, Prof.Hongfang Yu, and Prof.Dusit Niyato)

Federated Learning Framework Design in Industrial Metaverse   *Feb 2022 – Present*

- **Background**: This work mainly focuses on the non-i.i.d streaming data collected by distributed edge devices in Industrial Metaverse.(e.g. OCR applications in industrial parks.)
- **Challenge**: data heterogeneity/limited band width/ catastrophic forgetting towards streaming data
- A dynamic FL training paradigm designed for rapidly changing streaming data while eliminating data heterogeneity.
- A knowledge maintained online learning method for FL to prevent catastrophic forgetting
- Task decomposition in federated learning to reduce communication pressure on edge networks
- This work is the extended version of FedGSP. We plan to submit it to IEEE TPDS soon.

Semi-Supervised Federated Learning for IoT   *Jun 2021 – Sept 2022*
- This work aims to develop an applicable federated learning mechanism for IoT devices in semi-supervised settings, considering personalization and communication efficiency simultaneously.
- We introduced neural network pruning techniques into semi-supervised federated learning and a novel structure-aware collaborative distillation approach which can aggregate models with different structures.
- This work is submitted to SDM 2023, finger crossed!

A Pytorch Implementation of LEAF   *Dec 2020 – Mar 2021*
- LEAF is a widely used benchmark for FL, which is originally implemented by TensorFlow.
- Reproduced the work in Pytorch version for rapidly growing Pytorch community.
- Details can be found in https://github.com/slz-ai/leaf-torch

Reconstruct Motion with Audio Data from Microphone   *Mar 2020 – Mar 2021*
- This work aims at using audio data collected by microphone to reconstruct user's state of motion during recording time.
- Conduct physical experiment/mathematical modeling/machine learning to explore the correlation between sensing data(collected by gyroscope, accelerometer sensor, G-Sensor)and audio data(collected by microphone in the same panel).
- This work is led by Shinan Liu(PhD candidate of Uchicago). It's my first research project in my freshman year where I learn basic skills of scientific research.

Dedicated MCU Design for Fourier Decomposition Function   *Apr 2021 – Jun 2021*
- Use VHDL language to design a MCU, which is compatible of MIPS instruction set and dedicated for Fourier Decomposition.
- It's a Digital Design competition, which aims at minimizing processing speed and hardware efficiency.
- Won 1st place among participating teams

AWARDS AND ACHIEVEMENTS

- **National Scholarship** in the session of 2019-2020.(Highest honor of undergraduate student)
- WAC Scholarship in the session of 2020-2021.(Only 10 undergraduate students in UESTC are awarded each year)
- 1st Outstanding Academic Scholarship in 2020 and 2021.(Top 5 % students)