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Applications of Federated Learning in Medical Imaging: Toward Smarter Healthcare Systems

Li Chun Huang[1, 2], Kai Chain[3], Cheng Shun Lee[4]

[1] Office of Medical Education and Research, **Zuoying Armed Forces General Hospital, Kaohsiung**, **Taiwan**
[2] School of Nursing, Fooyin University, Kaohsiung, Taiwan
[3] Department of Information Engineering, I-Shou University Kaohsiung, Taiwan
[4] Department of Computer and Information Science R.O.C Military Academy, Kaohsiung, Taiwan

Taiwan

Introduction

Motivation

- **Healthcare Advancements**: Machine learning (ML) and deep learning (DL) are transforming healthcare through, predictive analytics, and intelligent diagnostics.
- **Medical Imaging Challenges**: Liver segmentation in CT scans is critical for diagnosing diseases like cirrhosis, hepatitis, and liver cancer, but manual annotation is time-consuming and prone to variability.
- **Data Privacy Concerns**: Sharing sensitive patient data across institutions raises privacy and regulatory issues, limiting collaboration.
- **Federated Learning (FL) Solution**: Enables collaborative model training without sharing patient data, addressing privacy and diversity challenges.

Objective

- Develop a semi-automatic federated learning algorithm for liver CT image annotation.
- Improve segmentation accuracy while ensuring data privacy and enabling collaboration across institutions.

Results

| Model \ Average (AG)	Sensitivity %	Specificity %	F1–Score %
3D U-Net (FL)	**82.7**	**81.8**	**81.9**
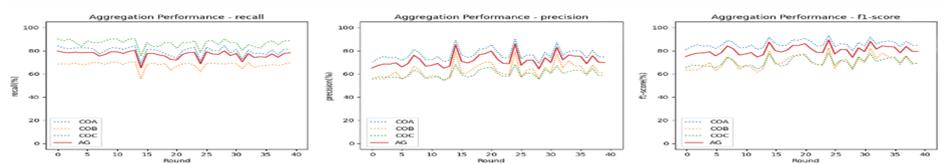
Conclusion

- ✓ Demonstrated successful application of federated learning for liver CT image annotation.
- ✓ Improved segmentation accuracy while preserving patient privacy.
- ✓ FL enables secure, collaborative, data-driven healthcare systems, enhancing patient outcomes and operational efficiency.

Future Work

- ✓ Expand dataset diversity to further improve model generalization.
- ✓ Integrate FL into broader clinical workflows for real-time diagnostic support.
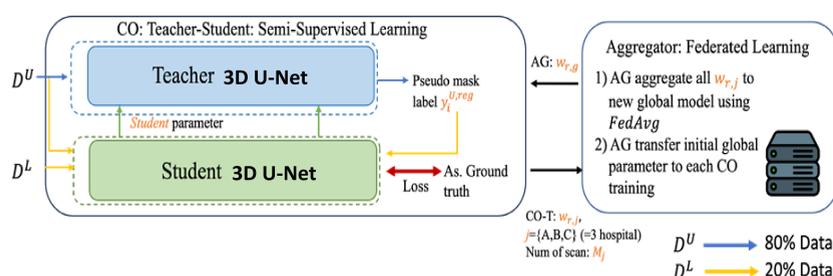
Methods

Hospitals Federated Learning System

Teacher-Student: Semi-Supervised Learning System
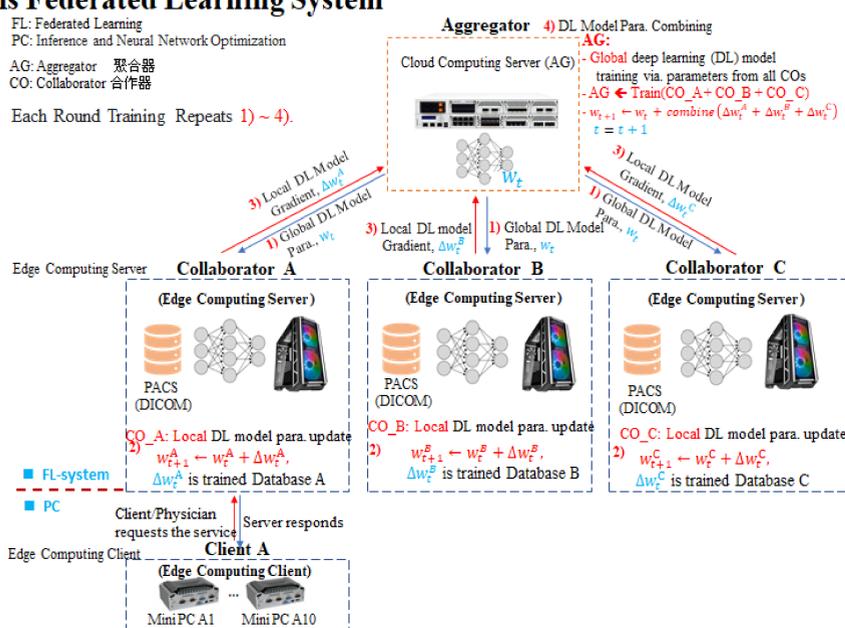
■ Data Distribution

Ratio of Train, Validation and Test based on CT image is 54 : 6 : 40

Me Dataset	Train	Validation	Test	Total
Patients	955	127	550	1632
Tumor Number	3290	399	2500	6189

We using a teacher-student framework, the algorithm reduces the time required for recognition and annotation. It leverages the 3D U-Net model for liver segmentation and integrates federated learning to enable decentralized training while ensuring data privacy. Pre-training utilized an open dataset of 1,632 patients with 6,189 tumor numbers CT images, annotated by experts.

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hlc1201@gmail.com