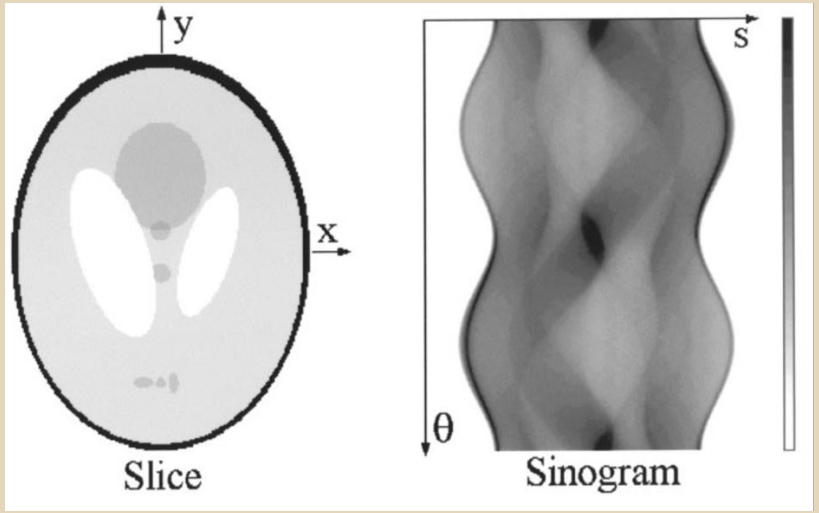
Federated Learning of Medical Image Reconstruction

Advisor: Dr. Mitra



Agenda

Goals and Motivation
Approach
Novel features/functionalities
Algorithms and Tools
Technical Challenges
Milestone 1, 2, 3
Task Matrix

Background

For a SPECT scan a patient is injected with a tracer, and then scanned with gamma cameras.

The image then has differing levels of brightness representing the amount of tracer found in that part of the body, captured in different angles.

These images are then reconstructed so that medical professionals can easily read them.

The second semester group is developing a machine learning model to perform this reconstruction quicker.

Goal

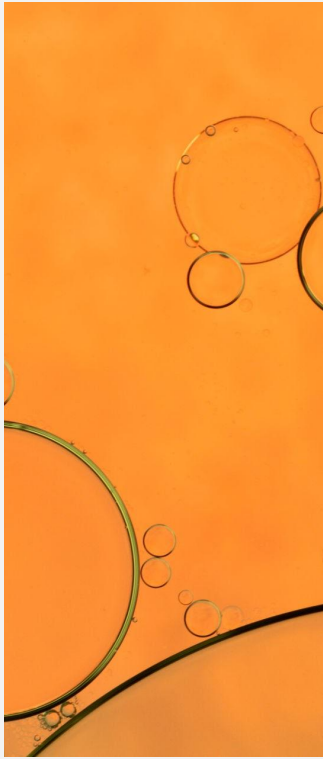
Our project is focused on improving this model by:

- Augmenting the size and quality of training data
- Incorporating federated learning

Approach #1

Augment the size, quality, and diversity of the existing dataset by improving the data generation pipeline by the following ways:

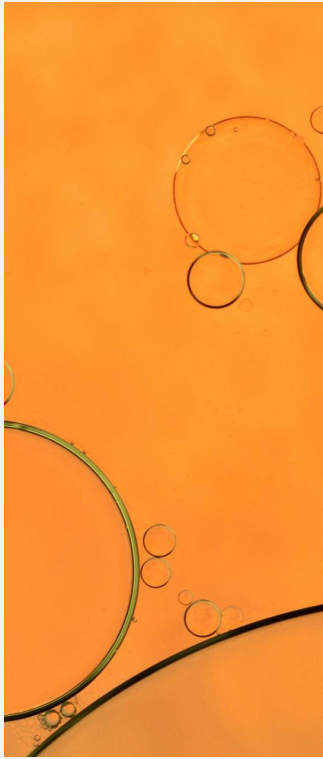
- Include new synthetic images of human bodies and organ anomalies (e.g., heart infractions)
- Train the existing model with diverse, realistic synthetic data
- Will be improved as used more by medical professionals who use the model and add new data



Approach #2

Federated Learning Integration with the model

- Enables training with real medical data from contributors while ensuring data privacy
- Realized through two applications: orchestrator, facilitates the learning, contributor, allows to use the relevant data to contribute to learning



Novel features/ functionalities

- Applying Federated Learning is not novel, but we want to focus on proven techniques from other fields and use it in a new problem space
- With our knowledge, we are the first to train a machine learning model to reconstruct medical images from SPECT scans, using synthetic data with artificially introduced heart infractions

Algorithms/Tools

Medical Image Reconstruction Tools

- Python - Language that facilitates the entire pipeline
- XCAT Phantom - Creates full-body images of the human body
- OpenGATE - Physics simulator used to simulate the output of a SPECT scan
- PyTorch - Train and use machine learning models
- Fiji (ImageJ) - To view medical images reconstructed from the model

Technical Challenges

Half team is new to biomedical engineering and machine learning

Will have to learn about the current machine learning pipeline in order to add on to the project

No real-world experience with federal learning

Milestone 1

- Compare and select technical tools for federated learning, UI, etc.
- Provide small (“hello world”) demo(s)
- Resolve technical challenges
- Create Requirement Document
- Create Design Document
- Create Test Plan

- User interface for orchestrator application
- Training data can be uploaded
- An initial model for federated learning gets randomly initialized, if not uploaded
- Data generation pipeline simulates sonograms and synthetic human body images

Milestone 2

Milestone 3

- Generated data can be uploaded to train machine learning program
- Machine learning model can reconstruct medical images from sinograms
- Authentication for trusted contributors
- Specification on which contributors to train model
- Updates on when new data has been uploaded by contributors

Task Matrix

Task	Joshua	Izzy	Tanuj	Yash
Select Collaboration Tools	25%	25%	25%	25%
Create Requirement Document	10%	10%	40%	40%
Create Design Document	70&	10%	10%	10%
Create Test Plan	10%	40%	10%	40%

Task Matrix

Task	Joshua	Izzy	Tanuj	Yash
Compare and Select Technical Tools	Federated Learning & Network	User Interface	Authentication	Orchestra/ Business Logic
Provide Demos	Federate Learning & Network	User Interface	Authentication	Orchestra/ Business Logic
Familiarize with Existing Pipeline	25%	25%	25%	25%
Research Federated Learning	70%	10%	10%	10%

Questions?