Federated Learning of Medical Image Reconstruction

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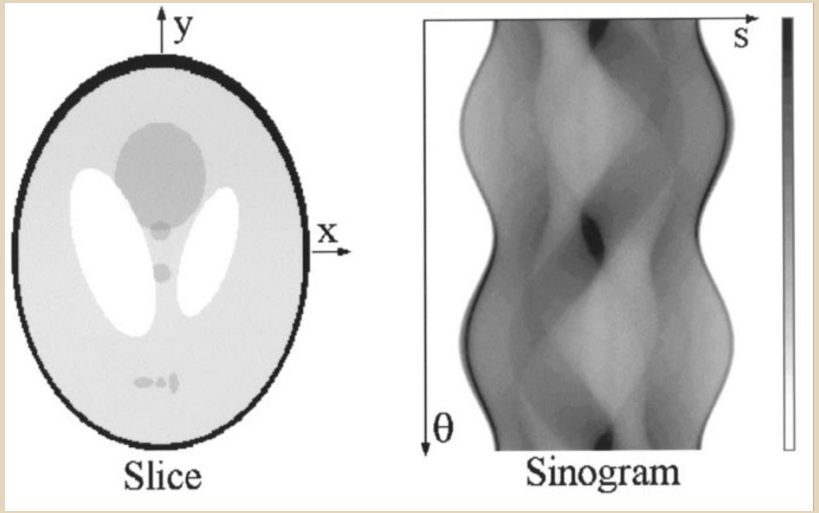


Agenda

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

Part 1
Goals and Motivation

Goal

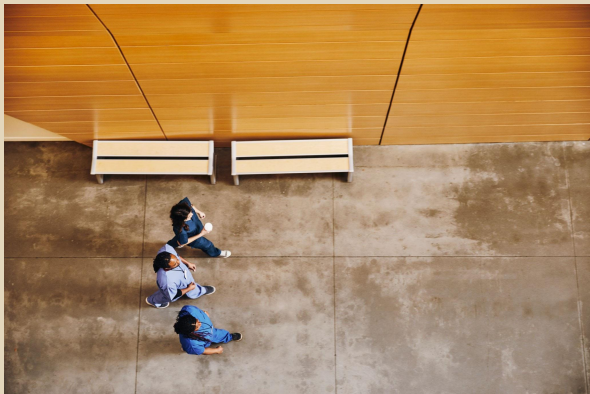
A SPECT scan creates 3d models by injecting the patient with radiation and taking multiple images of the radiation.

Traditionally analytic and iterative algorithms are used to create these models.

However these algorithms are slow (typically 30sec to a min), and sometimes result in a image with artifacts.

Thus, the goal of this project is to use deep learning models to drastically improve the accuracy of the existing machine learning model

Part 2
Approach



Approach

To improve the accuracy of the existing machine learning model, there are two parties involved:

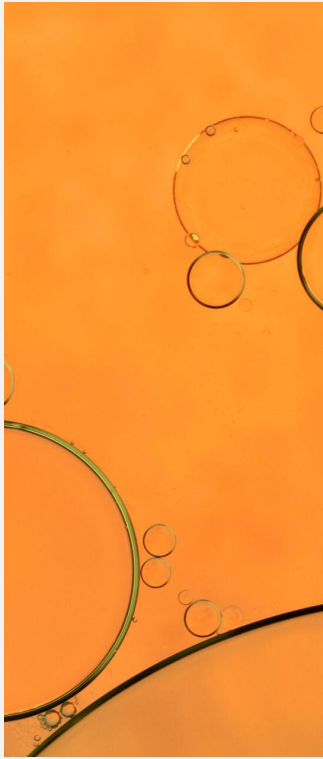
- Learning Managers
- Medical Professionals

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



Part 3
Novel features/ functionalities

- Applying Federated Learning, is not novel, realized through a project known as MELLODDY 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 training a machine learning model to reconstruct medical images from SPECT scans, using synthetic 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

Federated Learning Frameworks:

- Flower
- Substra
- PySyft
- OpenFL

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

Milestone 2

- Implement, Test, Demo Orchestrator Application
- Implement, Test, Demo Contributor Application
- Implement, Test, Demo Machine Learning Pipeline
- Assisting other team and testing on their data for the model

Milestone 3

- Implement, Test, Demo Orchestrator Application
- Implement, Test, Demo Machine Learning Pipeline
- Assisting other team and testing on their data for the model

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%

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%

Questions?