

Milestone 2 Progress Evaluation

1. Project title, names and email addresses of team members (CSE members first)

Project Title: Tomographic Medical Image Reconstruction using Deep Learning

Group Members: Asher Burrell (aburrel2022@my.fit.edu), Christopher Hinton (chinton2022@my.fit.edu), Ty Mercer (tmercerc2022@my.fit.edu)

2. Faculty Advisor: Dr. Debasis Mitra, dmitra@fit.edu
3. Client: See Faculty Advisor
4. Progress of current Milestone (progress matrix)

Task	Completion	Asher	Chris	Ty	To do
Learn how to use Open-GATE simulation	100%	33%	33%	33%	
Learn Pytorch syntax (secondary)	100%	33%	33%	33%	
Get sinogram generation pipeline working	100%	0%	0%	100%	Finish generating all SPECT data

5. Discussion (at least a few sentences, ie a paragraph) of each accomplished task (and obstacles) for the current Milestone:

- Task 1: Learn to use Open-GATE simulation.

We were able to set up a session with Tommy Galetta to show us the Open-Gate software. During the session, we were able to learn about the entire pipeline for the sinogram generation, and each member was able to get hands-on experience with the simulation software. Also, we were able to successfully upload scripts into some of the data folders that are used by the Open-Gate software.

- Task 2: Learn Pytorch syntax (secondary)

During another session, Tommy was able to introduce us to the code for the machine-learning model. All of us were able to learn the basics of PyTorch, either through classes at Florida Tech

or through prior machine learning experience. Also, all of us understand the structure and code for the PyTorch model.

- Task 3: Get sinogram generation pipeline working

We were able to successfully set up a Python script to generate the sinograms. This task was accomplished by Ty Mercer. There were a few difficulties with replacing the old Powershell script that was used in the lab before with our new Python script, however, these were quickly resolved after a meeting with Tommy. Also, due to the hurricane and fall break, we had to delay the deployment and running of the script by a week and a half. Furthermore, there were some issues where the parameter file was previously configured to track only the heart (and not other organs. Also, the parameter file did not set IDs to distinguish between the left heart region and right heart region. Ty was able to resolve these issues, but as a result, we do not have as many sinograms generated at this time as we originally intended.

6. Discussion (at least a few sentences, ie a paragraph) of contribution of each team member to the current Milestone:

- Asher Burrell

Asher Burrell arranged the meetings with Tommy Galleta to help all of our team members learn how to use the Open-Gate simulation. He also learned about the PyTorch model architecture and presented it in Senior Design class. Finally, he wrote most of the progress evaluation.

- Chris Hinton

Chris Hinton helped Ty and Asher learn more about how to use the Open-Gate simulation software since he already had experience with it. He created most of the presentation and helped Ty Mercer debug the Python script that is used for our model pipeline.

- Ty Mercer

Ty Mercer was able to successfully create a Python script that automatically generates 5 sinograms roughly every two and a half days. He met with Tommy to load the script into the current model pipeline. Also, he is currently working on generating the rest of the sinograms. The script is able to generate sinograms, store them in folders by timestamp, and log how long it takes for each sinogram to be generated.

7. Plan for the next Milestone (task matrix) or [skip if this is for Milestone 6]

Task	Asher	Chris	Ty
Generate 1,000 sinograms using the model pipeline	10%	10%	80%

Develop a new machine learning model to classify the generated sinograms	40%	40%	20%
Train and tune the PyTorch AED model to start reconstructing the sinograms based on the data we have currently	35%	35%	30%
Figure out how to run OpenGate on a multithreading program.	33%	33%	33%

8. Discussion (at least a few sentences, ie a paragraph) of each planned task for the next Milestone or "Lessons Learned" if this is for Milestone 6

- Task 1: Generate 1000 sinograms using the model pipeline

This was originally supposed to be completed by Milestone 2, however, due to the hurricane and some technical difficulties outside our control, it has been pushed back to Milestone 3. To accomplish this task, we will have Ty run his Python script that generates five sinograms every 2 and a half days.

- Task 2: Develop a new machine learning model to classify the generated sinograms

Although we do not have all of our data generated as of now, we will still continue to create a new machine-learning model that accomplishes our goal of classifying and reconstructing the sinograms. All three of our members will be contributing to this task.

- Task 3: Train and tune the PyTorch AED model to start classifying the sinograms based on the data we have currently.

To get around our issue of having a lack of data, we will mainly experiment with few-shot learning methods in the beginning using modified forms of AED models that already exist in the lab. As we acquire more data, we will be able to switch to a standard train/test procedure.

- Task 4: Figure out how to run OpenGate on a multithreading program.

In order to meet our deadline of producing 1000 sinograms, we will need to up the production process by using multiple cores or cloud computing resources. However, we will need to find out how to run OpenGATE from whatever servers we plan to use for the generation process.

9. Date(s) of meeting(s) with Client during the current milestone:

10/28/2024

10. Client feedback on the current milestone

See Faculty Advisor feedback below.

11. Date(s) of meeting(s) with Faculty Advisor during the current milestone:

10/28/2024

12. Faculty Advisor feedback on each task for the current Milestone

- Task 1: Learn how to use Open-GATE simulation

Advisor Feedback: Ty learned it and set it up on multiple computers.

- Task 2: Learn Pytorch syntax (secondary)

Advisor Feedback: Okay.

- Task 3: Get sinogram generation pipeline working

Advisor Feedback: Sufficient training data generation is a problem as Monte Carlo projection by OpenGate of each augmented heart takes a long time. Reducing the dimension could be an approach, but then the test data needs to be reduced too. Another approach may be to use $(FAF^{-1})P$, given P as the sinogram, A the geometrical augmentation operator applied to the ground truth XCAT+ phantom, F forward projection with system matrix (attenuated with XCAT attenuation map), and F^{-1} is backprojection with the same system matrix. However, this will add noise and possibly mess up training. Only clean alternative is to generate as many OpenGate projections as possible.

Faculty Advisor Signature: _____ Date: _____

13. Evaluation by Faculty Advisor

- Faculty Advisor: detach and return this page to Dr. Chan (HC 209) or email the scores to pkc@cs.fit.edu
- Score (0-10) for each member: circle a score (or circle two adjacent scores for .25 or write down a real number between 0 and 10)

Ashe r Burre ll	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Chris tophe r Hinto n	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Ty Merc er	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10

Faculty Advisor Signature: _____ Date: _____