

### Milestone 3 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](mailto:aburrel2022@my.fit.edu)), Christopher Hinton ([chinton2022@my.fit.edu](mailto:chinton2022@my.fit.edu)), Ty Mercer ([tmercer2022@my.fit.edu](mailto:tmercer2022@my.fit.edu))

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

Task Matrix for Milestone 3	Completion	Asher	Chris	Ty
Generate 1,000 sinograms using the model pipeline	100%	10%	10%	80%
Develop a new machine learning model to classify the generated sinograms	100%	40%	40%	20%
Train and tune the PyTorch AED model to start reconstructing the sinograms based on the data we have currently	90%	35%	35%	30%
Figure out how to run OpenGate on a multithreading program.	100%	10%	10%	80%

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

- Task 1: Generate 1,000 sinograms using the model pipeline

Due to errors in our data generation process that were caught in the middle of this milestone, our progress in this task was delayed. However, we were eventually able to generate this many sinograms through the use of data augmentation.

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

This task was accomplished by modifying the AED that was previously used on a different project in Dr. Mitra's lab. This modified AI was successfully trained on approximately 250 of our synthetic sinograms.

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

This task was accomplished in conjunction with Task 2, by modifying the existing AED from Dr. Mitra's lab. The model can be successfully trained on our synthetic data, with preliminary results showing accurate reconstructions of our simulated data. Further testing and refinement, particularly on real data, is still needed, and will be our primary focus next semester.

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

This task was accomplished relatively quickly by Ty, who was able to adapt the existing code to multithreading. This in combination with a large amount of data augmentation allows us to generate data very quickly.

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

- Asher Burrell

Asher Burrell assisted Ty with testing the data augmentation pipeline script to ensure it was producing SPECT images that were rotating in the right directions. He also wrote most of the presentation for Milestone 3 and drew the diagrams of the pipelines. Finally, he started training and fine-tuning the Auto Encoder model.

- Chris Hinton

Chris Hinton worked on the code for attenuation-corrected SPECT reconstruction, which is a slightly modified version of SPECT reconstruction that is believed to produce visually clearer images. This was not explicitly done for our Senior Design project, but it will be useful when testing the AI next semester. Additionally, Chris modified and debugged the decoder side of the Auto Encoder/Decoder we created.

- Ty Mercer

Ty Mercer worked on the data augmentation pipeline script, which allowed us to create x25-x50 synthetic data from our original data. This includes rotating the data and also using forward and backward projection augmentation techniques. He also continued to

generate sinogram data and resolve issues with how previous data was generated. With our original sinograms and their corresponding augmentations, Ty was able to generate 1000 data points by the end of this milestone.

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

Task Matrix for Milestone 4	Asher	Chris	Ty
Generate 3,000 sinograms using the model pipeline	10%	10%	80%
Train and tune the PyTorch AED model to start reconstructing real sinograms based on the data we have currently	35%	35%	30%
Validate the model on synthetic data through AI Panther	45%	45%	10%
Incorporate the validation scoring method for reconstruction quality	40%	40%	20%

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 3,000 sinograms using the model pipeline

Currently, we have 1000 sinograms generated. We can generate 5 sinograms every two and a half days. This rate should allow us to generate at least 2000 sinograms over the course of the winter break. This rate can be improved if we are able to get the sinogram generator OpenGATE on another computer. We are trying to migrate it to another computer right now, and hope to resolve some simulation issues.

What sinograms we generate is an important consideration. We need to make sure we set the parameters correctly to fully enumerate many possible heart variations. We can finalize a better rate analysis once we confirm whether OpenGATE is running on the other computer. From there, we can determine how many heart variations we can complete sinograms for.

- Task 2: Train and tune the PyTorch AED model to start reconstructing real sinograms based on the data we have currently

The training and tuning is a task that will continue until the end of the project. Recently, we were able to fix the model pipeline so that it correctly works with the new set of input data that we have generated. Also, we have begun some basic training tasks and experiments. Currently, our loss function shows a flat curve, indicating that we should experiment with reducing the training time. We will experiment with this over the course of the winter break.

- Task 3: Validate the model on synthetic data using AI Panther

Now that we have a functioning model, we will start to validate the model's reconstructions on synthetic data that we have not shown it before. We will also experiment with moving the entire codebase for the training and testing to AI Panther. If we can successfully do that, we will be able to train our model much more quickly than we are currently. Also, we will be able to remote connect to the AI Panther computer and run the training script without being on campus.

- Task 4: Incorporate the validation scoring method for reconstruction quality

Our validation method right now simply involves looking at the reconstructed image and determining whether it looks somewhat similar to the original image of the human heart. We would like to make this process more precise. Therefore, we will be experimenting with various validation scoring methods to determine exactly how far off the reconstructed image is from the original image. Completing this task would allow us to improve how we fine-tune the model.

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

11/22/2024

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:

11/22/2024

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

- Task 1: Generate 1,000 sinograms using the model pipeline

Advisor Feedback: Done or close.

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

Advisor Feedback: They are experimenting correctly.

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

Advisor Feedback: I will check shortly, but they report 600 epochs takes approximately an hour.

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

Advisor Feedback: They tried new software that did not work, but it is multithreaded manually.

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](mailto: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)

Asher Burrell	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Christopher Hinton	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Ty Mercer	0	1	2	3	4	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10

Facutly Advisor Signature: \_\_\_\_\_

Date: \_\_\_\_\_