

## Milestone 4 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 ([aburrell2022@my.fit.edu](mailto:aburrell2022@my.fit.edu)), Christopher Hinton ([chinton2022@my.fit.edu](mailto:chinton2022@my.fit.edu)), Ty Mercer ([tmercerc2022@my.fit.edu](mailto:tmercerc2022@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 4	Completion	Asher	Chris	Ty
Generate 3,000 sinograms using the model pipeline	98%	10%	10%	80%
Train and tune the PyTorch AED model to start reconstructing real sinograms based on the data we have currently	95%	35%	35%	30%
Validate the model on synthetic data through AI Panther	95%	45%	45%	10%
Incorporate the validation scoring method for reconstruction quality	100%	40%	40%	20%

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

Task 1: Generate 3,000 sinograms using the model pipeline

This task is mostly complete. All technical issues have been resolved and our process is now generating 25 sinograms every 5 days consistently. Additionally, we are finalizing scripts to randomly generate more parameter files for our simulation, and scripts to automatically start our simulations again (so that we don't have to go back into the lab).

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. The model pipeline is currently running and major improvements have been made. We are currently training on 1500 sinograms, with input and output pairs. Additionally, we have separated some sinograms to be used for validation and testing. Now the model can separate various regions of the heart from each other. Our only obstacle now is the fact that the training time has increased drastically due to model architecture changes. We plan to mitigate this issue by switching everything to AI Panther.

#### Task 3: Validate the model on synthetic data through AI Panther

All the training data, validation data, and model scripts have been uploaded to AI Panther. Also we have set up a GitHub repository to store past versions of the model and update them accordingly so that they can be accessed either from AI Panther or from our local machines. The only roadblock now is to fix a couple environment issues that occasionally arise when we try to run the model scripts.

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

Over the past month, we have researched several validation methods. We have settled upon SSIM as our main evaluation function. We have found that training with one of the image validation metrics increases our model's performance drastically. Whereas before, we were only able to reconstruct the outer shape of the heart, now we can separate different regions of the heart. Our only roadblock with this task is that training using an image validation function as the loss drastically increases training time. We hope to continue mitigating this issue with AI Panther.

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

##### ■ Asher Burrell

Asher was mainly focused on making further improvements to the ML model scripts. He was responsible for making changes to the architecture, loss functions, and validation metrics that drastically increased the model performance. Additionally, he has been the main person responsible for getting all training data, validation data, and model scripts running on AI Panther.

##### ■ Chris Hinton

Chris primarily focused on automating background tasks and refactoring our current methods, allowing us to generate our data more efficiently. He also helped to research

some of the image validation metrics that Asher implemented with the ML model, and served as the group's primary point of contact with Dr. Mitra.

■ Ty Mercer

Ty organized the runtime data for each synthetic data creation simulation (OpenGATE) into a spreadsheet in order to forecast how much data we can generate by the end of the semester. He also continued to initialize the simulations at each lab computer. He finalized a script to randomly generate simulation parameters and start data augmentation on our synthetic data automatically after finishing an OpenGate simulation.

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

Task Matrix for Milestone 5	Asher	Chris	Ty
Generate 5,000 sinograms using the model pipeline	10%	10%	80%
Continue to optimize training time in AI Panther	35%	35%	30%
Create project poster	33%	33%	34%
Test the AI on real medical data	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 5,000 sinograms using the model pipeline

This task is scheduled to be completed on time. All technical issues have been resolved and our process is now generating 25 sinograms every 5 days consistently. Additionally, we have finalizing scripts to randomly generate more parameter files for our simulation, and scripts to automatically start our simulations again (so that we don't have to go back into the lab). Our only issue is that we may need new sinograms.

Task 2: Continue to optimize training time in AI Panther

Currently training on AI Panther is about 10% faster than training on the local machines. We plan to decrease this time by performing more advanced GPU acceleration and looking at training multiple GPUs. Also, we are thinking about employing forms of distributed computing (including federated) to drive down times as well. If implemented, this last suggestion would be done in collaboration with the second senior project group.

### Task 3: Create project poster

We have already signed up for the senior design showcase. With this in mind, we will be focusing on creating a poster using all of our current documentation. This task will be completed by all members of the senior project group and the work will be divided equally between all group members.

### Task 4: Test the AI on real medical data

This is another task that will be done in collaboration with the Year 2 senior project group. Currently, we are validating the model's performance on generated sinograms. However, it is not clear if these generated sinograms are fully representative of real data. Therefore, we plan to replace our current testing data with real medical data in order to see how useful the model will be in the real world.

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

2/17/2024

#### 10. Client feedback on the current milestone

See Faculty Advisor feedback below.

### Task 1: Generate 3,000 sinograms using the model pipeline

Advisor Feedback: Seems on time.

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

Advisor Feedback: Adapted nicely.

### Task 3: Validate the model on synthetic data through AI Panther

Advisor Feedback: Provide timing comparison.

Task 4: Incorporate the validation scoring method for reconstruction quality

Advisor Feedback: Use at least 5 reasonable validation measures.

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

2/17/2024

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

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

Faculty Advisor Signature: \_\_\_\_\_

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