Q1) Project title
Topographic Medical Image Reconstruction using Deep Learning

Q2) Names and email addresses of team members (CSE members first--this is a plan for the CSE contribution)
Asher Burrell, aburrell2022@my.fit.edu
Christopher Hinton, chinton2022@my.fit.edu
Thomas (Ty) Mercer, tmercer2022@my.fit.edu

Q3) Faculty advisor from CSE: name and email address
Dr. Mitra, dmitra@fit.edu

Q4) Client: name and affiliation
Dr. Mitra, Florida Tech

Q5) Date(s) of Meeting(s) with the Client for developing this Plan:
8/23/24, 8/30/24

Q6) Goal and motivation: Discuss the overall goal (help make the intended users "happier") and motivation (why are the intended users not too "happy"? limitations/pains of current systems)
Topographic medical image reconstruction using deep learning. Right now, medical imaging with iterative statistical algorithms takes about 30 seconds. Using deep learning inferencing with our project would reduce this time to milliseconds, allowing massive amounts of data to be generated in a small amount of time. Additionally, our project includes synthetic data generation, allowing us to get good results without training on real data (effectively zero-shot learning), and our system can provide easy access to synthetic data.

Q7) Approach (key features of the system): Discuss at least three key features/functionalities that your system provides for the users to help achieve the overall goal (what features does your system have that can help make the intended users "happier"?)
(at least one paragraph for each feature, more specific less vague) [e.g. Similar to app descriptions at Google Play, **NOT the underlying tools]**
For interdisciplinary/external projects: focus on (identify) separate CSE features/contributions

a. The user can generate synthetic SPECT data using the system. This data will be realistic and will strongly resemble real human data. It will be captured in a physics simulation using a realistic human torso and callimeter. This controlled environment will allow all of the data collection to be as accurate as possible.

b. The user can reconstruct a 3D model of human organs using a pre-trained neural network. The neural network will be trained on our synthetic SPECT data, which will be of interest to researchers. However, a user who is only interested in an accurate SPECT image reconstruction need not worry about the training and can simply provide the data to be reconstructed. This reconstructed data will automatically be saved to the user's computer, so there will be no need to hunt for it later.
c. The user can view, resize, and rotate the reconstructed 3D model to identify potential heart defects. The output from the neural network will be an accurate representation of the real reconstructed data. As such, any heart defects that would be present in a traditional reconstruction will also be apparent in the AI reconstruction.

Q8) Novel features/functionalities: Discuss which features/functionalities, if any, are novel and why.

To the best of our knowledge, no one has ever done a 3D medical image reconstruction by training a neural network without real data.

The user can view the reconstructed image in milliseconds, whereas it would take upwards of 30 seconds using traditional reconstruction methods.

Q9) Useful Algorithms and Tools

We plan to modify an existing GATE simulation for synthetic data generation, and we will use a neural network, most likely implemented in Python using Pytorch among other common modules, for our AI. Existing algorithms from Dr. Mitra's BiCLab will be used to generate the validation data. Fiji/ImageJ will be used to view the generated data for validation.

Q10) Technical Challenges: Discuss three main CSE-related challenges (for example, "we plan to use/do javascript for web programming, but we don't know much about javascript").

The real number to integer conversion is a challenge for our system. Converting from floating-point real numbers to integers involves a loss of precision and speed, which will be detrimental to our project. More precise conversions can significantly slow down our process. We need to find a way to balance precision and speed to get accurate 3D images without taking too much time.

Nobody in our group has experience using neural networks to generate 3D images, and only one of us has any experience with medical images.

We have little to no experience using PyTorch for neural networks.

Q11) Milestone 1

- Learn about iterative reconstruction and the technology to be used for this project

    - Demo existing reconstruction techniques as a baseline for our project
- Make a simple ML design to be trained to provide the 3d image
- Set aside data as a validation set for the AI
- Create Requirement Document
- Create Design Document
- Create Test Document

Q12) Milestone 2

- Generate the synthetic SPECT data
    - Demo for presentation

Q13) Milestone 3

- Train the neural network on the synthetic data.
    - Demo for presentation

Q14) Task Matrix for Milestone 1

Task	Asher	Chris	Ty
Learn about medical imaging	50%	0%	50%
Learn about the technology we will be using for this project	40%	20%	40%
Create a baseline machine learning model	33%	33%	33%
Set aside real data as a validation set	0%	100%	0%
Requirement Document	15%	15%	70%
Design Document	70%	15%	15%
Test Plan	15%	70%	15%

Approval from Faculty Advisor

"I have discussed with the team and approve this project plan. I will evaluate the progress and assign a grade for each of the three milestones."

Signature: _____ Date: _____