Project Title:
Automated Cardiac Segmentation for Medical Analysis

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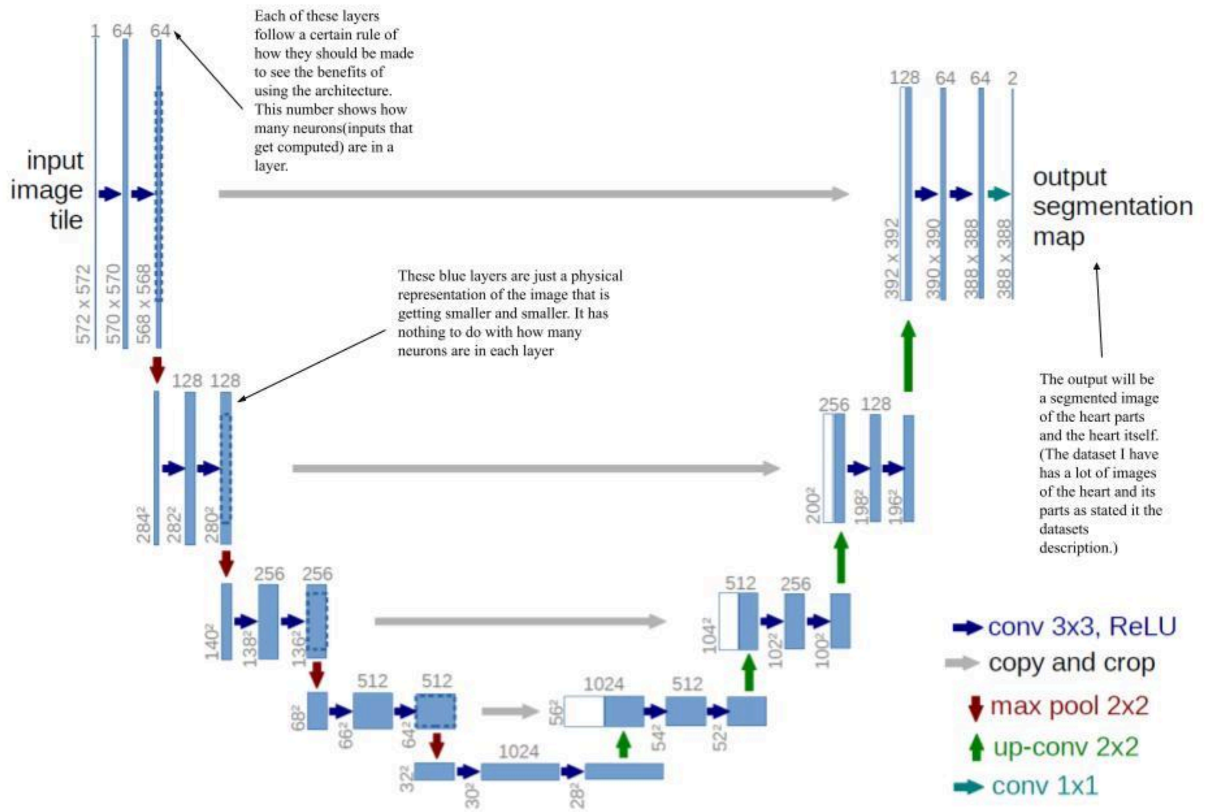
Abstract:
The use of machine learning in the health industry has been increasing since techniques for machine learning have been improving. This project aims to make and evaluate a machine-learning model for automated segmentation from cardiac magnetic resonance imaging (MRI). The model would be able to accurately segment the cardiac structures like the left ventricle to help doctors diagnose and treat their patients better. Due to the complexity of just learning how to make a machine-learning model for segmenting organs (in my case the heart), I will use the rest of this class to make a good model for segmenting a heart structure.

Designs and plans:

1. Obtain a dataset for training and testing
    - I have obtained a dataset for this and am working on how to work with the file that the images are contained in.
2. Preprocess the data. Account for color, and image resolution and normalize their values.
    - This is easily done with PyTorch's image generators that I have learned about while researching PyTorch
3. Either design a convolutional neural network that uses the u-net schema or (very likely) use transfer learning
    - I could just keep testing similar models of U-net architecture that are slightly different from my own making. The design of the architecture is easy enough to follow:



- I'm still not sure how to use transfer learning. I am working on how to use it in the project.

4. Train the model using the annotated dataset, employing techniques such as data augmentation, transfer learning, and fine-tuning to enhance generalization
   - Data augmentation isn't hard, it seems similar to how TensorFlow does it (which I have experience with due to using it last semester).
   - I expect to work more closely with Professor Mcneil as we try to improve the model once I decide on using transfer learning or my U-Net model.
5. Evaluate the performance of the trained model using quantitative metrics, including the Dice similarity coefficient (DSC) and Hausdorff distance

Tentative Schedule:

I'm still working on learning how to use the data and make a model. I have been heavily slowed by personal reasons and other classes but I'm trying to be and do better. I will be making regular updates to my repository going forward with updates to time logs explaining what I have done for the day. Here is a chart showing a rough schedule of tasks to do in order to fulfill the steps for the plans above. I can't give exact days, as I am not sure how long each phase of learning how to do a task will take. This is because segmentation itself is such a challenge. Much of the chart excludes information about learning done to achieve the designs and plans. That information of exactly what was learned will be in time sheets and posted to the repository.

Tasks	Estimation of time needed
Learn about the dataset (the files contain a lot of different data)	3 weeks
Load the data and separate the data into different groups (use data augmentation by using pytorch data augmentation objects)	1 week
Make my neural network to segment the images or use transfer learning (very likely using transfer learning since making my own would take a tremendous amount of time)	1 week
Adjust hyperparameters of the model that I end up choosing to make the model more accurate	3-4 weeks
Explore options to make the model usable by a userbase (doctors)	2-3 weeks

Data Sources:

- This data will be used to segment the images of the left ventricle. The data is here https://www.cardiacatlas.org/sunnybrook-cardiac-data/. It is from a segmentation challenge held years ago. It holds images of the left ventricle. Not only images of the left ventricle, but it also provides other files with details such as the correct contours or places where the model should be labeled as "left ventricle" and "not left ventricle". The actual data is from a paper: Radau P, Lu Y, Connelly K, Paul G, Dick AJ, Wright GA. "Evaluation Framework for Algorithms Segmenting Short Axis Cardiac MRI." The MIDAS Journal - Cardiac MR Left Ventricle Segmentation Challenge, http://hdl.handle.net/10380/3070
- I will likely be using transfer learning to segment the left ventricle and have found a repository that offers up a pre-trained model that is retrainable. https://github.com/chfc-cmi/cmr-seg-tl

Use Cases:

- The biggest use case of the project is to be able to segment images of the left ventricle. This means that by the end of the processing of the images, the image should indicate what makes up the left ventricle and what doesn't.
- A model accurate enough to segment the left ventricle helps doctors diagnose and treat their patients better
- Offers useful visualization to be used by medical students and anyone interested in learning about the left ventricle