

Iowa Initiative for Artificial Intelligence

Final Report

Project title:	Prediction of internal cochlear anatomy from standard clinical imaging		
Principal Investigator:	Nicholas George-Jones, MD; Nathan Kemper, MD; Alexander Claussen, MD; Phillip Gander, PhD; Marlan Hansen, MD		
Prepared by (IIAI):	Yanan Liu		
Other investigators:			
Date:			
Were specific aims fulfilled:		N	
Readiness for extramural proposal?		N	
If yes ... Planned submission date			
Funding agency			
Grant mechanism			
If no ... Why not? What went wrong?		Results are not convincing due to small dataset and not sufficiently good ground truth	

Brief summary of accomplished results:

We developed and validated a U-net model to automatically segment internal cochlear anatomy. Averaged Dice Similarity Coefficient between AI predicted segmentation and manual segmentation was 0.59, 0.57 and 0.07 for the different area of interest.

Research report:

Aims (provided by PI):

The goal is to provide a surgeon a visualization of how they can expect the orientation of the cochlea to appear during surgery.

Data:

A dataset of 70 fully segmented presurgical CT scans that have the surgical areas of removed bone from patients undergoing cochlear implant surgery were segmented as well as two important anatomical structures.

AI/ML Approach:

In this study, a U-net model was implemented for segmentation using Python. Patient-level training/validation split was 42/28. Each slice of each case was treated separately in 2D due to small data set. Total 19,109 and 13,023 slices were used as training and validation.

Experimental methods, validation approach:

Data Preparation

Data preparation or pre-processing is an essential step in any machine learning study. In this project, we converted all our CT datasets in compressed Nifti format (nii.gz). Data normalization is an important step which ensures that each input parameter (pixel) has a similar data distribution. This makes convergence faster while training the model. We normalized the image intensity to [0,1] using its maximum and minimum values and we resized the input image to [128,128] for computation time.

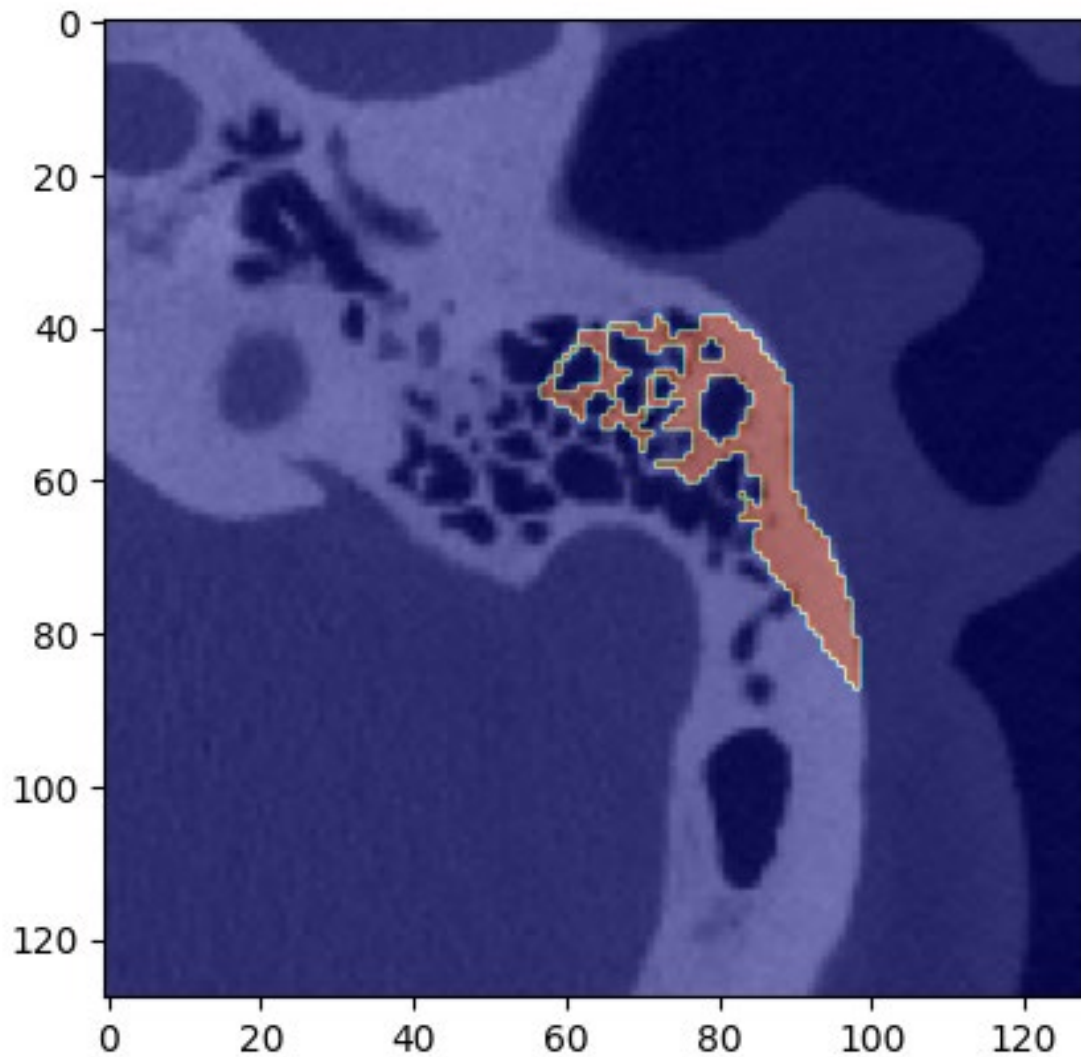


Figure 1. Input example overlaid with its segmentation mask

Unet

The Unet is convolutional network architecture for fast and precise segmentation of images. In this project, Unet was implemented with Keras functional API, which makes it extremely easy to experiment with different interesting architectures. (<https://github.com/zhixuhao/unet>) Input

was the preprocessed CT images. Output from the network is a 128x128 image which represents mask that should be learned. Sigmoid activation function makes sure that mask pixels are in $[0, 1]$ range.

Results:

Averaged Dice Similarity Coefficient between AI predicted segmentation and manual segmentation was 0.59, 0.57 and 0.07 for the different areas of interest (surgical areas of removed bone from patients undergoing cochlear implant surgery as well as two important anatomical structures).

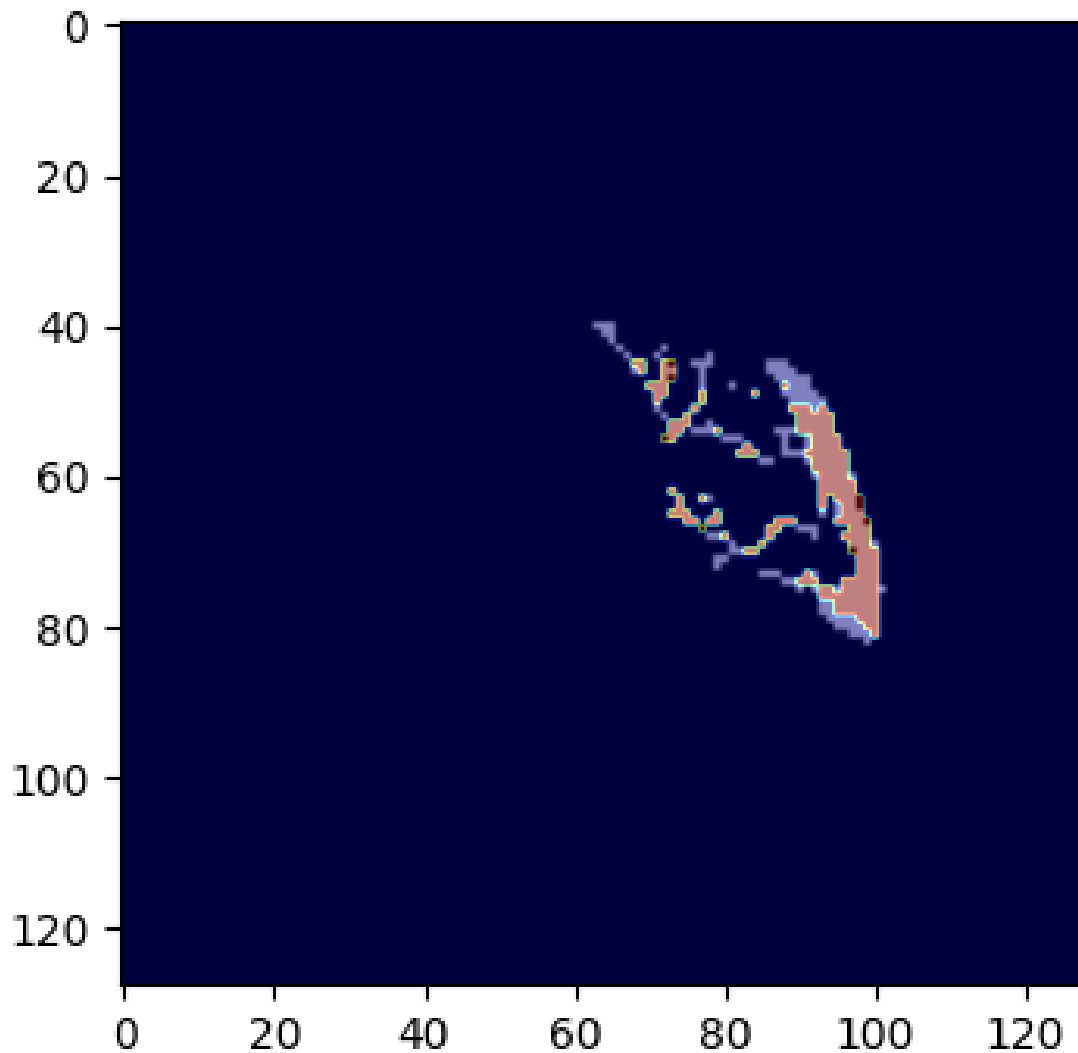


Figure 2. Result example: ground truth (gray) overlaid with predicted result (red)