Diagnosis of Breast Tumor Using Deep Learning

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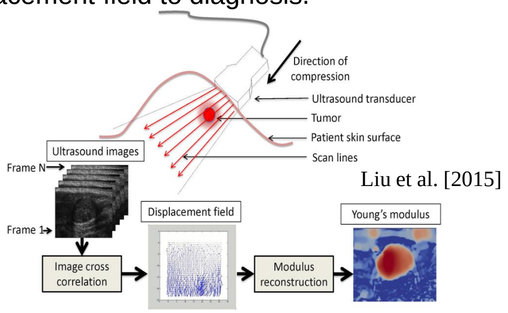
Introduction

Doctor visits are often accompanied by series of tests. If a tumor is found, a biopsy is suggested. A biopsy is an often controversial procedure that removes the affected tissue for further analysis and diagnosis. Though biopsies provide accurate results and are more detailed than ultrasounds, they are invasive, expensive, painful, and increase chances of complications and side effects. To avoid biopsies, researchers have tried to come up with a new technique of diagnosing diseases: elastography. This process is non-invasive. Scans of tissue are taken during an ultrasound test. Then, using image cross-correlation, the displacement field of tissue deformation is obtained. From there, an inverse elasticity problem is solved to produce a shear modulus map. A diagnosis is made through the modulus image. To avoid the expensive inversion algorithm, Professor Oberai's group is trying to develop a new learning based workflow that circumvents the inverse problem and goes directly from the displacement field to diagnosis.

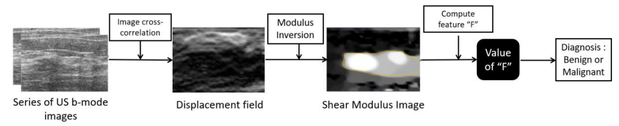


Liu et al. [2015]

Figure 1 : Elastography process

Objective & Impact of This Research

The objective of Professor Oberai's this research project is to create an algorithm that trains a neural network to classify the tumors as benign or malignant using displacement measurements. This is beneficial because it doesn't require the invasive biopsy process or the solution of inverse problem which is quite expensive, time-consuming, and challenging to solve.



Standard Ultrasound based Elastography workflow

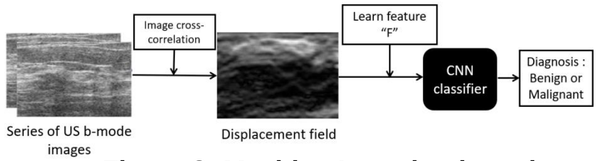


Figure 2: Machine Learning based workflow – no inversion problem

Skills Learned

Over the course of SHINE, I have learned many new skills, including the basics of machine learning and Python. While watching videos on machine learning, I acquired knowledge in calculus, such as how to find gradients and derivatives. I was also introduced to back propagation and gradient descent algorithms as well as the concept of cost functions. In addition, I spent some time learning how to perform simple addition, subtraction, and multiplication operations on a matrix. Perhaps the most significant thing I learned was neural networks and how they work. A neural network is a set of algorithms loosely modeled after neurons in a human brain.

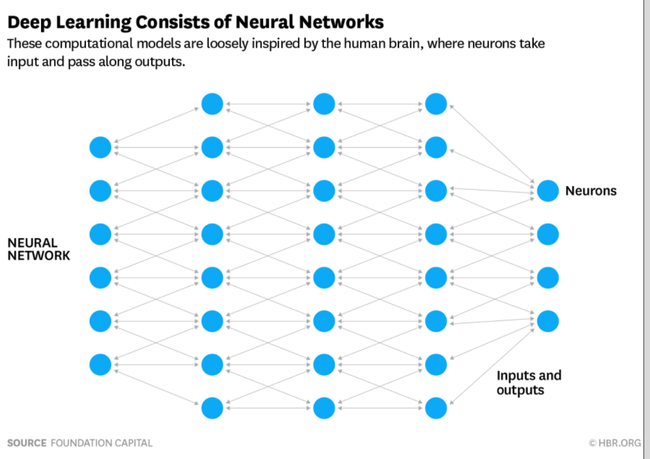


Figure 3: Neural Network

Results

We used synthetic data to train the neural network (Figure 4) and used the learned weights to predict the actual patient data (Figure 5) and made the correct prediction, which was a malignant tumor.

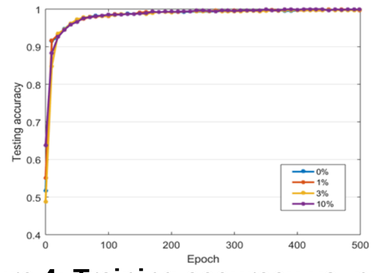
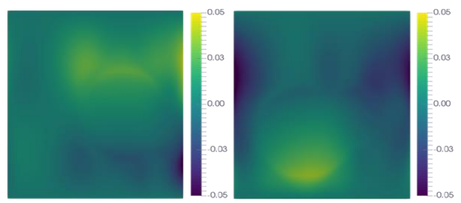
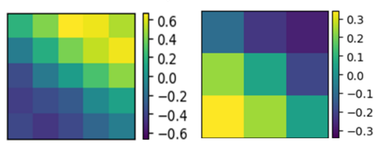


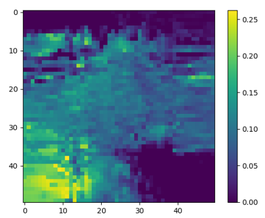
Figure 4: Training accuracy vs. number of iterations



Training the neural network with synthetic data



Learning the parameters of the model



Doing prediction on a real data using learned weights

Diagnosis: Malignant

Figure 5: Transfer learning

How This Relates to Your STEM Coursework

As the weeks of SHINE passed, I was exposed to new topics that could help me with my STEM coursework next school year. Learning how to program loops, array/matrixes, and conditional statements in Python this summer will definitely help me in my intro to computer science course. I also learned a bit of calculus, including gradients and taking the derivative as well as linear algebra, which will help me in my later years of high school and college.

Next Steps for You OR Advice for Future SHINE Students

After SHINE, I am interested in entering my project into a science fair or competition of some sort. I will continue to practice coding in Python and re-watching the machine learning videos in my free time.

Advice for future SHINE Students:

- Don't be afraid to step out of your comfort zone
- Stay curious – ask as many questions as you can

Acknowledgements

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