Math 499 Independent Study (Research) for Spring 2017

Course Catalog Description: Individual study or research under faculty supervision.

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Student Responsibilities:

The student (Hope Miedema) will be using statistical classification methods for tumor detection. She will use R in multivariate data sets, write a paper for The Manhattan Scientist and give a presentation at the end of the semester. We will meet every week and I will expect between 8-10 hours of work for this project per week. Her grade will be based on the interactions during the weekly meetings, the computer code, the paper and the presentation.

Topic: Optimization of Magnetic Resonance Imaging (MRI) Using Statistical (Machine) Learning

Project Description:

Magnetic Resonance Imaging (MRI) is a versatile medical imaging modality that is limited because it is slow. In this work we will optimize the performance of methods to accelerate MRI using statistical detection theory and statistical learning along with computer programming in R and MATLAB.

Medical images are acquired because of specific clinical reasons but that is not how medical imaging systems are typically optimized. Usually they are optimized using physical characteristics such as resolution and noise. This approach is reasonable for systems which are linear and have the same noise over the entire image. Current approaches for accelerating MRI are not linear and have different noise for different parts of the image. The new methods (for example compressed sensing (Figure 1) or low-rank matrix approximations) are non-linear and create unpredictable artifacts in the images. For these images, a better method of optimization is one that specifies the clinical task such as detecting a tumor. We will use statistical detection of simulated tumors as a way of optimizing imaging systems. Statistical learning will be used to find computationally efficient ways to estimate the detectability of tumors.

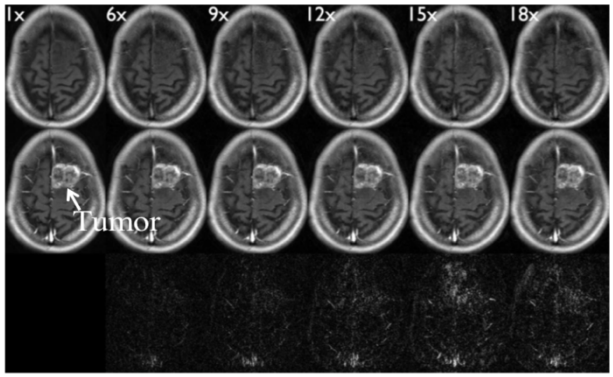

Figure 1. MRI images of two brain slices (top two rows) at different accelerations (1x to 18x). The bottom row is the error image due to acceleration. This assessment does not quantify the effect of the error on detection of small tumors. In this work, we will develop the methodology to assess the acceleration in terms of the detectability of tumors.

The goal is to use the detectability of tumors to quantify the information content of images from accelerated MRI.