**1. SPECIFIC AIMS**

Medical image segmentation is one of the first and most important steps in the image processing pipeline for diagnostic medicine. It involves separating regions of an image into meaningful, homogenous regions, in order to assess a patient for pathological conditions, surgical planning and intervention. Specifically, there has been substantial research in the methods used for MRI brain segmentation, where brain image regions are defined and classified based on tissue type and anatomical structure. Manual segmentation is time-consuming and subject to various operator variability issues, leading to the development of computerized segmentation methods. There exist multiple techniques for creating MRI-brain segmentations, each with its own advantages, disadvantages and complexity. Optimization-based segmentation in a technique in which a cost function is defined based on a segmentation model. This function is minimized to find the global optima. The most commonly used segmentation model is the Potts model, a specific case of the general Markov Random Fields (MRF). In this model, the cost function consists of an L2 norm of the data term and minimizing candidate, and an L0 metric of the gradient of the minimizing candidate. Although an elegant way to model segmentation, this formulation is non-convex. As a result, finding a global minimizer of the cost function is non-trivial, and a topic of current research. To address this difficulty, we propose to develop and compare two separate optimization algorithms for minimizing the Pott’s model cost function. *Specifically, we aim to:*

**Aim 1: Develop a conjugate gradient optimization algorithm, found in the literature, for the segmentation of an idealized Shepp-Logan brain phantom.** The methods outline Guerrou et al. will be replicated in order to segment a Shepp-Logan phantom with varying levels of artificially created noise and artifacts. Computational time and the DICE coefficient will be used as quantitative metrics for the analysis of this algorithm.

**Aim 2: Develop a genetic algorithm which minimizes the same cost function as in Aim 1, and apply it to the segmentation of an idealized Shepp-Logan brain phantom.** Genetic algorithms used stochastic processes to avoid the optimization challenges of non-convex formulations. By implementing a genetic algorithm for segmentation using the same cost function as in Aim 1, we can make a comparison between the the conjugate gradient method from aim 1 and the genetic algorithm from aim 2. Computational time and the DICE coefficient will be used as quantitative metrics for the analysis of this algorithm and its comparison with the previous method.