ES-2 Final Project: Initial Report (2018 ES-2)

Student name: Sejal Dua

Student Lab section: LC - Thursday 6:00-7:15pm

Project title: Clustering Alzheimer's and Dementia Neuroimaging Data

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Abstract:

Alzheimer's Disease is a neurodegenerative disorder of unknown pathogenesis that primarily affects elderly people and is the most common cause of dementia. MRI scans provide neuroimaging data which illuminate key distinguishing features between a healthy brain and impaired brain. Without the help of a qualified doctor, MATLAB functions can be used to cluster imaging data, compare statistical data obtained from the clusters to healthy statistical data, and diagnose Alzheimer's Disease and/or dementia. A common clustering algorithm called k-means is used to determine if the MRI scan has any features resembling those common in Alzheimer's patients. Then, to improve the robustness of the algorithm, a hierarchical clustering technique is used as a work-around for the fact that the number of clusters or voxels is unknown. The GUI window and clustering data outputted by the algorithm together work to automatically identify the state of the human brain in various MRI scans.

Brief description of functionality (1-2 sentences each)

1) Overall idea

   The project will provide an interactive GUI window through which the user can examine various brain scans (available in drop-down menu). From the window, there will be data analysis options such as basic reports of symmetry, cross-sectional area, cluster center coordinates using k-means approach, cluster center coordinates using k-medians approach, and cluster center coordinates using agglomerative hierarchial clustering, an approach that is commonly used when the number of clusters (or voxels) is unknown. The user will learn key characteristics of Alzheimer's and dementia MRI scans from interacting with the images in the GUI window (set up

with help from a MATLAB guide video), and the finale of the project will be a data analysis report displayed for a particular image with the press of the 'Show Statistical Report' button.

2) Core calculations done

Calculations will be dependent on the image matrices fed into the function. To provide some introduction for the project, though, I think I will import a csv file with Alzheimer's and dementia demographic data and do a quick statistical analysis of that with some interpolation and extrapolation. Calculations are not necessary prior to importing the data.

3) Does the project use one of the "numerical methods" covered in the class (numerical integration, numerical differentiation, setting up and solving matrix problems, data fitting, descriptive statistics)? If not, you should carefully review the project with TAs or Prof Tracey.

The project uses setting up and solving matrix problems, data fitting, and descriptive statistics. If time allows, more complicated clustering techniques may be explored, and these models would inevitably pose a matrix problem.

4) How does the user run the program?

The user runs the program by interacting with the GUI window. Input .mat files and jpegs will be imported in the script that launches the GUI window. The user just gets to explore the images and buttons as they wish.

5) How will outputs be stored?

Outputs will be stored in structures, most likely, and then displayed when their corresponding buttons are pressed.

6) The project should include an example the grader can run. What do you think this will be?

The GUI window is the perfect "example" that the grader can run. It would also be cool to allow the user/grader to import his/her own MRI jpeg file to analyze. If it is not too difficult to code, this option might be available.

7) Does the project require input data, and if so, do you know where to find such data?

This project requires input jpeg files. Data also needs to be read in from two different csv files. I have the csv files for the Alzheimer's demographic information as well as cross-sectional and longitudinal data. The images were taken from two sites: one called Medscape - Alzheimer's Disease Imaging (https://emedicine.medscape.com/article/336281-overview) and the other called Kaggle – MRI Brain Image (https://www.kaggle.com/jaishofficial/mri-brain-image/data). I would have preferred to take them from a site called ADNI – Alzheimer's Disease Neuroimaging Initiative, but I would have to request access to the data, which I am not qualified to do.

Preliminary software design

1) List the core ("Priority 1") functions of the project – what are "must-have" functions. If possible, write a function definition line for each listing likely inputs and outputs

function centerVecs = InitializeCenters(dMat, nClus)
function dist = ComputeDistance(dMat, centerVec)
function ixClusIDs = ReassignClusters(dist)
function sumDist = GetSummedDistances(dist, ixClusIDs)
function centerVecs – UpdateClusterCenters1(dMat, ixClusIDs)
function name_Pushbutton_Callback(hObject, eventData, handles)
... many more

2) List "Priority 2" functions of the project – functions are not absolutely critical, but which you hope to complete.

function mortalityInterp = alzMortalityInterp(vec, nYears, ...)

^ functions similar to the one above

3) If you have ideas for how you could further extend the project if you have time, list those here
   - Preliminary: interpolation and extrapolation of Alzheimer's and dementia demographic statistics/history
     - Would involve super straightforward histogram / boxplot graphs
     - Helpful to understand the gravity of these diseases
   - Complicated extensions
     - Hierarchical clustering algorithms
     - Spatio-temporal modeling to examine functional connectivity in the brain
   - Embellishment
     - Allow the user to import their own neuroimaging data to view in the GUI window

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Issues or concerns

I am concerned about getting my hands on more neuroimaging data. In a perfect world, I would have fMRI data and PET (positron emission tomography) data, but currently, I just have a few brain scans with unique key features (still interesting, but imaging data is looking a little slim).