Graphical User Design

Current Graphical User Interfaces (or GUIs) within the medical field are limited to simple designs due to the focus on the performance of the application or medical device. The main goal of GUI design within the medical field is to focus on simplicity over anything else. The graphical user interface for the tumor malignancy prediction will also focus on simply displaying the data in a manner that is not only familiar to radiologists but is also interpretable by any medical professional.

Graphical User Interface Features

Loading the data will be based on a selector that connects to either a local server within the hospital or directly copies the location of the DICOM files within the computer. For the first iteration, a Picture Archiving and Communication System (PACs) is regularly used at hospitals to store and transfer images throughout devices (Strickland, 2000). This will prevent the loss of the input data while allowing for the use of said data to make predictions. Once the data is loaded, one can move on to displaying the data before making the predictions.

A list containing the name of files to predict will be shown. The images will not be displayed, but the name of the file should provide the user with the information required to know whether obtaining the prediction of the file is high or low priority. Once the predictions are made upon the input data, a report will display visualizations about the types of cancers diagnosed as well as certain data about the patients. A list at the bottom will link to the annotated images. Here the images from the DICOM file will be displayed and some buttons will be included to display the other images. Factors relevant to cancer, such as age, whether the patient smokes, and more will be displayed to the right of the image display. Each image will contain an annotation highlighting the region of interest (the likely tumor), and at the bottom right of the image the prediction of the tumor will be made. In the case that corrections are required, the user will have the ability to mark the prediction as wrong.

Once the user corrects the prediction, the DICOM file will be marked to be added for the training set over the weekend. Besides the ability to correct predictions, the user will not be able to further edit the DICOM file within the GUI application. The focus of the GUI application is to display the results of predictions made by a machine learning model to assist radiologists in determining the malignancy of tumors. Because of the aforementioned, the focus will be on the visualization of the data and the report generation. The general dashboard will contain the most visualizations.

Understanding the data is key to developing a dashboard with the proper visualizations. DICOM files not only contain image data, but also a header file containing numerical, categorical, and even textual data about the patient in question. The bar chart will be used to compare the number of positive cases against negatives based on age, ethnicity, and even sex (Metwalli, 2021). For the categorical data, such as the type of cancer, pie charts will be used to show the proportions between categories (Metwalli, 2021). Once the predictions have been fully examined and the user is satisfied with the results, they will be able to download the summary dashboard in the form of a report. The report will contain all of the visualizations shown in the summary report with the added table containing the name of each DICOM file, and its prediction.

Graphical User Interface Elements

The Graphical User Interface will be comprised of five different pages. The first page will be the loading page, where the user will be able to list the DICOM files to make predictions on to the application and read a list of the file names. This page will contain 4 buttons and an empty list, the buttons will be from right to left predict, add, remove from list, and cancel/close. Once the predict button is hit, the page changes to a loading screen where one can tell the progress, and how long until the predictions are finished. Once the model finishes its predictions, a third page summarizing the input data together with the prediction will be shown. This page will behave similar to a dashboard and contain a set of visualizations pertaining to the type of cancer, the prediction, the ethnicity, age, probability of the prediction, a separate visualization comparing the predicted malignant tumors against the predicted non-malignant tumors based on age and ethnicity (to observe whether this follows usual patterns where likelihood of malignant tumors increases with age). The page will also contain at the top right a download report button to allow the user to create a report summarizing the model’s predictions. This can then be used to report on the finished predictions for distribution to doctors. At the very bottom of the dashboard there will also exist a list of links each leading to the fourth page of the application.

The fourth page of the application will contain the main image of the DICOM file together with annotations on the image itself and some visualizations to the right of the image. The annotated image within the DICOM file can then be saved using pydicom by creating a new DICOM file and fill in the annotated data on the Overlay Plane field of the Grayscale Softcopy Presentation State group (Innolitics, n.d.). The annotated image will be presented to the radiologist with the prediction at the bottom right of the image itself. An arrow pointing to the right will be on the bottom right of the dashboard and another arrow pointing to the left at the bottom left of the dashboard will be present to allow the user to move through the DICOM files and observe the data in more detail. As DICOM files may contain more than one image, there will be two semi-transparent buttons (one on the left and one on the right) to allow the user to observe all images within the DICOM file (Varma, 2012). The page will also contain certain information from the prediction and the header information within the DICOM file. In its detail it will contain the information from the Segmentation group of the header data which contains the weight, age, allergies, smoking status, and many other factors of the patient (Innolitics, n.d.).

Once the data has been fully analyzed by the user, the user can then click on the save button found at the bottom center of the page to lead them to the fifth page. On the fifth page, the user will be able to select which images to save by using a selection of buttons. The user can choose to save all files by clicking the save all button or select several files with the original file name with the addition of the word “\_pred” at the end of the filename and click the save button, the last button which will be found on the bottom left next to the save button will be the do not save button. This is to allow radiologists the flexibility of saving a selection of files in the case that there is not enough memory to save all of the new files, or they were only testing the functionality of the algorithm.

Source(s):

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