Baseline Functions Descriptions

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## General Purpose

These functions were created to assist Pawas in his research paper. Generally, his paper looks at how the D95 dose is affected by use of 4DCT, TR-4DMR, RC-4DMR in planning. These functions show how the different modalities map the movement of the tumor and create histograms to show the frequency of finding a tumor at certain locations.

## Function 1: waveformStats

This function takes a set of time and displacement values as input (two columns in an excel file) and generates graphs that highlight the significant extrema. It determines significant extrema by filtering for a minimum prominence, which is manually inputted by the user. Prominence is the measure of how much an extremum stands out by comparing its vertical distance to the closest adjacent extrema (if the point is a maximum, its adjacent extrema are assumed to be minima). The intent of this was to remove extrema created by noise. Then, by averaging adjacent extrema data points, the function creates midpoints that trace a pseudo-baseline of the waveform. This is also plotted on top of the original waveform. Finally, the extrema and averages as well as their time values are stored in an Excel file on three separate worksheets. Note that the function will only perform these calculations between the first and the last minima of the waveform – anything prior or after those two points, respectively, is ignored.

## Function 2: waveformStats\_4DCT

This function operates similarly to waveformStats, but after finding the significant extrema, it finds the average displacement of the tumor over one cycle. Seeing that 4DCT has an essentially sinusoidal waveform, the function determines average displacement by averaging all the position values of the original waveform between two minima (one cycle). This average displacement is displayed as a horizontal line on top of the original waveform.

## Function 3 & 4: waveformHistogram & combinedWaveformHistogram

The waveformHistogram function operates similarly to waveformStats, but after finding the significant extrema, it generates a histogram of the waveform comparing the amplitude to that amplitude’s frequency per cycle. Rather than ranges, the function bins by horizontal lines – the value of a bin increases depending on the number of intersections that horizontal line has with the original waveform. The lines are equally distributed, with the range and number of lines being inputted manually. This binning process is done by iterating through adjacent extrema (assuming minima are only adjacent to maxima and vice-versa) and finding all horizontal lines that fit between those values. The bins corresponding to those lines are incremented. Lastly, these bins are divided by the total number of cycles, which is manually inputted by the user. These values are then plotted as a histogram and the values are stored in an excel file. The combinedWaveformHistogram function builds on the waveformHistogram function by running for two files, 4DCT and 4DMR, and producing a combined color-coded histogram.