Read Me

Quick Notes:

- Make sure you have all necessary input files saved to the folder you're in first, i.e. for the menus code you should make sure you have CLData from CL_Extraction and the xlsx file from the Changepoint code saved to this folder.
- You'll be running simulations for multiple segmentations and people, make sure you title all input and output files accordingly

1. CL Extraction - Matlab

Input: csv file from paraview
Output: CLData and xlsx file

Functions: Given centerline data from VMTK in the form of a csv file, *Network_Extraction* organizes vessel info, such as length and radius, from each vessel and saves it to a matlab cell and also creates a connectivity matrix, a matrix that shows how the vessels are connected to each other. Then *Export_to_Excel* takes the information from this cell and converts it to an xlsx file.

Steps:

1. Open the centerlines file from VMTK in Paraview. Select "save data" and save the file as a .csv file with 13 points of precision. Save the .csv file to *CL Extraction* folder
2. Open *Network_Extraction*
3. In command window type *Network_Extraction("yourcsvfile.csv")*
   When prompted answer questions with '1' then '0' then '1'

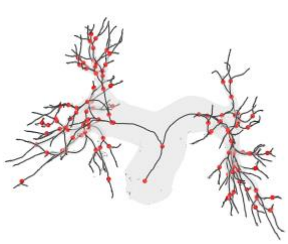
```
Command Window
>> Network_Extraction("Centerline.csv")
Do you have the nodes for this Network? 1: Yes, 0: No
1
Does this network have a clamp? If so, input scaling below or put 0 for no scaling:
0
Was the root vessel found? 0 - No, 1- Yes
1
```

4. Open *Export_to_Excel*
5. On line 8, make sure the data file name matches the one you get from *Network_Extraction (e.g. CLData.mat)*.
6. In line 156, change xlsx file to the name you want to save it as for R
7. Run lines 32 - 158

Figures:

1. Save your stl file from Paraview to the CL Extraction folder
2. In CL Extraction folder open *plot_geometry*
3. On line 6 make sure the stl file matches the name you have.

for the centerlines and junctions you want to plot.



2. **Change Points - R**

Input: xlsx file from CL Extraction
Output: xlsx file with changepoints

Functions: GlobalFunctions reads the data from the xlsx file. Then it detects change points using mean and variance. Then it adds changepoint data to the new xlsx file.

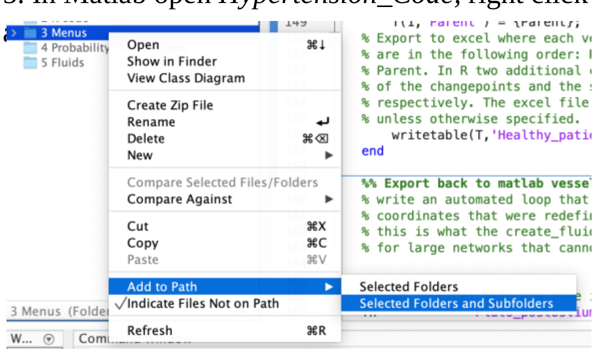
Steps:
1. Save xlsx file created from CL Extraction to *Changepoints_R* folder
2. Open *LocateChangepoints.Rmd*
3. In line 20 make sure the xlsx filename is the same as the one created from *Export_to_Excel*
4. In line 21, q should be equal to n - 1 changepoints that you want, plot should be equal to FALSE if you want to see the plots and TRUE if you don't, and the xlsx filename should be changed to what you want to save as.

3. **Menus - Matlab**

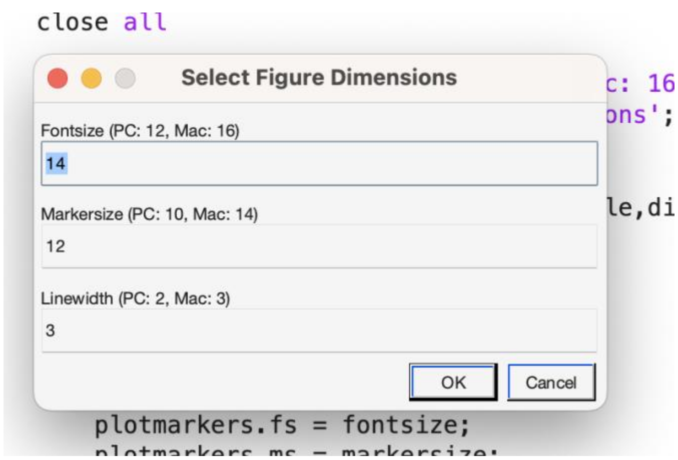
Input: CLData and xlsx file with change points from R Code
Output: connectivity_matrix.mat, vessel_radii.mat, changepoint_locations.mat, vessel_details

Functions: *ImportBack* will read xlsx file and make it into a matlab cell and overwrite the radius, length, and xyz coordinates that were redefined in R. *get_changepoint_locations* reads vessel data and returns a cell that contains each vessel's length and radius at each change point and the slopes between each changepoint. *get_radii* takes the vessel and changepoint data and runs the radius algorithm (see paper) and returns a cell with the predicted radius, standard deviation, and the region of the vessel that was considered. *conn2* takes the vessel, connectivity, and vessel radii dataset, and will return a matrix that contains the connectivity, radius, length, and standard deviation for each vessel. *daughter_check* identifies vessels which violate one or more of our assumptions (see paper) and calculates the percent error for both assumptions individually. *calculate_radii* calculates a new radius for the vessels that violates our assumptions.

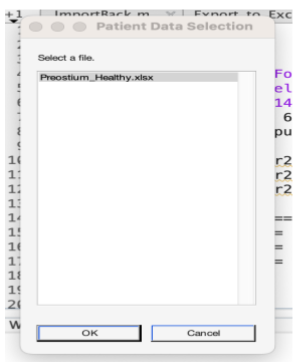
Steps:
1. Open *Menus* Folder
2. Save CLData file from CL Extraction to *CLData* folder
3. Save xlsx file from R Code to *ExcelData* folder
4. Save stl file from Paraview to *Segmentations* folder
5. In Matlab open *Hypertension_Code*, right click on the folder *Menus*, hover over *Add to Path*,



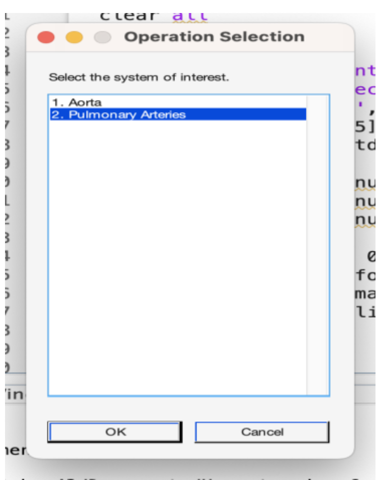
6. Open *menus* folder in Matlab
7. Open *main_menu* code and run
8. Set *Fontsize, Markersize,* and *Linewidth* to your liking and press ‘OK’



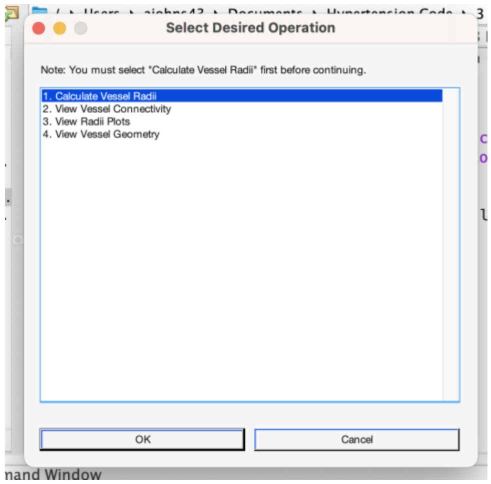
9. Select desired xlsx file



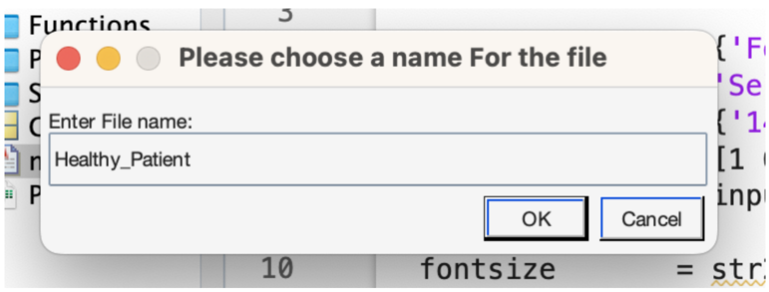
10. Select system of interest



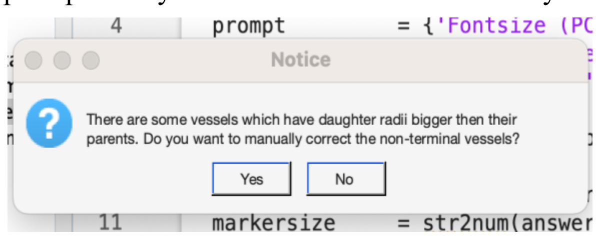
11. Select *Calculate Vessel Radii*



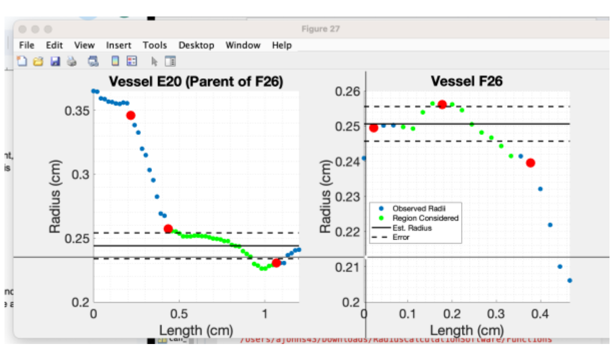
12. Select CLData file for the patient you're using
13. You will get the prompt 'Calculating vessel radii. This may take some time.' Select 'OK'
14. When it asks you for a file name, select a name that will help you best identify the patient you're working on.

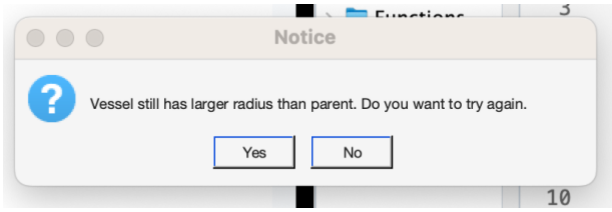


15. If you want to manually correct daughter radii bigger than parent, select 'Yes' when prompted. If you don't want to correct this or you don't receive this prompt proceed to step 17.

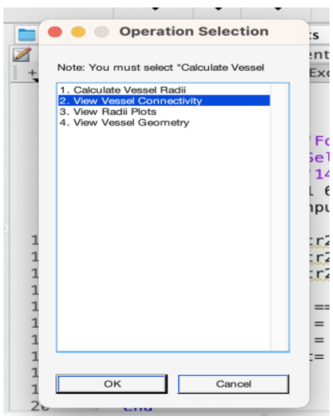


16. To manually correct radius, use crosshairs to select start and end points from left to right for desired radius. If the daughter radii is still bigger than the parent you will be asked if you want to try again. If you don't select 'No' and proceed.





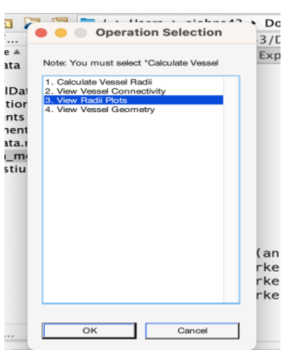
17. Select newly created patient data when prompted
18. Select *View Vessel Connectivity*



19. Check that there are only real numbers in the matrix, if there are any ‘NaN’ you’ll have to start the menus code again.

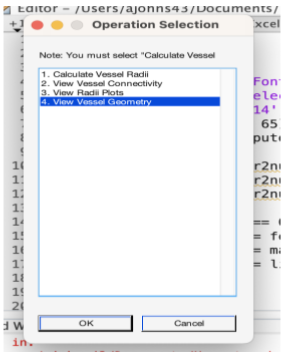
OPTIONAL for steps 20 through 24

20. Select *View Radii plots*



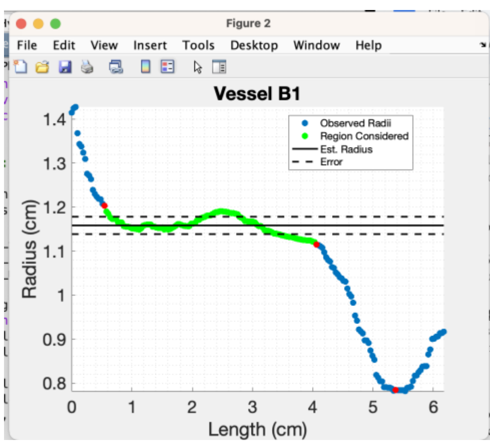
21. Select minimum and maximum value for which vessel_radii plots you want to see.

22. Select View *Vessel Geometry*



23. Select desired STL file
24. Select minimum and maximum for desired vessels.

Figures:
1. Open *Plot_Radius_Selection*
2. On line 1 make sure the mat file you're opening is the same one defined in step 14
3. On line 6 set the index
4. After you run this code All figures will be saved to your *Figures* folder



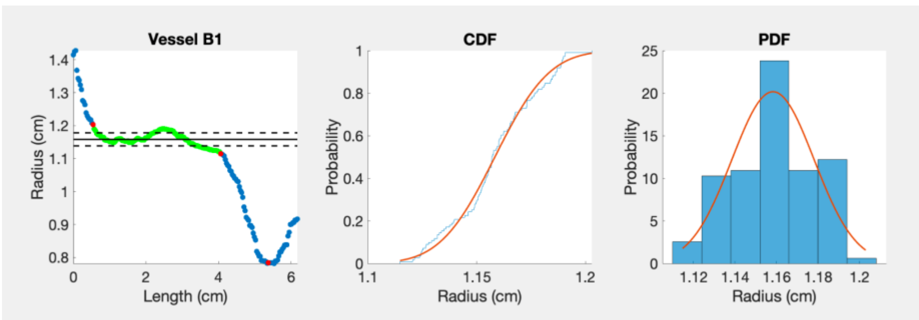
4. Sampling - Matlab

Input: vessel_details, connectivity_matrix
Output: connectivity.txt, terminal_vessels.txt, dimensions.txt

Functions: *prepare_for_fluids* artificially extends the lengths of the vessels. *sample_radii* samples from the probability distribution from the radius region with a normal distribution. *create_fluids_data* exports the information needed for the fluids code and exports it to text files. *export_for_fluids_control* creates a folder containing the text files for fluids for the control. *export_for_fluids_sample* creates folders containing the text files for fluids for the samples.

Steps:
1. From the *Patients* folder in *Menus* save the mat file from your current patient to the *Sampling* folder, the name should be whatever you saved in step 14 in the *menus* code. From the *Data* folder in *Menus*, save *connectivity_matrix.mat* to *Sampling* folder.
2. Open *Sampling* Folder
3. Open *create_radii_samples*
4. On line 6 set the index to the amount of samples you want

Figures:
1. Save *Data* Folder and *Patients* Folder from *Menus* to *Sampling* Folder
2. Open *Plot_CDF_PDF*
3. Set index on line 5 and line 46



5. Fluids - Matlab

Input: data_fluids folder
Output: pressure and flow output

Functions: *run_1D* is a driver file that will run the systemic fluids model from c++ and fortran by passing parameter values needed by the model.

Steps:
1. Save data_fluids from Sampling folder to Fluids folder
2. Open *run_fluids_samples*
3. On line 3 set the lowest and highest sample number you want. (Sample 0 is the control)
4. In the command window type *run_fluids_samples(start, end)*, where *start* is the sample you want to start on, and *end* is the sample you want to end on. For example, if you want to simulate samples 450 through 480, you type *run_fluids_samples(450, 480)*

Figures:

1. Open *plot_pressure_flow*
2. Index for lines 34 and 80 should be 0 for the control
3. Index for lines 8 and 57 should be set to which samples you want to plot.