
Table of Contents

.....	1
1 - Setup Constants, Filenames	1
- 2 Get Scan Parameters	1
3-Load the 4D data - time, slice, image(x,y) - Note: this will take a long time	2
4 - Calculate baseline intensity, Make Enhancement Images (normalize to baseline), max slope and max peak maps	2
5 - Display Baseline average image, Enhancement Image at timepoint 30, and Parameter Maps for the selected slice	3
6 - Create Right Peripheral Zone ROI & Left Peripheral Zone ROI -- Compare suspicious region to contralateral side	5
7-Calculate & Display ROI stats	8
8- Plot uptake curves vs. time in seconds	10
9 - Calculate Washout Slope for the 2 ROIs as a linear fit to the last half of the timepoints	11
- Reset directory out of data folder	12
- Answer Questions from Lab Handout	12

% DCE Analyses

1 - Setup Constants, Filenames

```
close all;
clear all;
%maxenhance = xxx;
%basetime = xx;
Slice = 10; % Select a slice to work with, e.g. 10

%Defining directories
DCE_dir = 'data/E317/1009/';
rootname = 'E317S1009I';

%Collect the name of all the images
%cd DCE_dir ;
cd 'data/E317/1009';
i=1;
ImName = strcat(rootname,num2str(i),'.DCM');
tempres = 10.471; %temporal resolution in sec (based on data, but
use as constant here)
```

- 2 Get Scan Parameters

```
%Extract some variables from info of the first image
DCEinfo = dicominfo(ImName);
numfiles = DCEinfo.ImagesInAcquisition;
numtimepts = DCEinfo.NumberOfTemporalPositions;
numslices = numfiles / numtimepts;
```

3-Load the 4D data - time, slice, image(x,y) -

Note: this will take a long time

```
% Open files - data is stored file1=slice1, time 1; file2 = slice2,
time 1 ...
for t = 0:(numtimepts-1)
    for i = 1:numslices
        filenumber = t*numslices + i;
        ImName = strcat(rootname,num2str(filenumber),'.DCM');
        DCMinfo = dicominfo(ImName);
        ImDCE(t+1,i,:,:)= dicomread(DCMinfo);
    end
end
```

4 - Calculate baseline intensity, Make Enhancement Images (normalize to baseline), max slope and max peak maps

```
%Can just use data from 1 slice
RawS1 = squeeze(ImDCE(:,Slice,:,:));

% Initialize accumulation variables and max variables to 0

baseline = zeros(1,256,256);
enhancement = zeros(30,256,256);
slope = zeros(30,256,256);

% Loop over all slices --- or analyze just for your selected slice

% Find average of baseline points
baseline = mean(RawS1(1:5,:,:));

% Loop over all timepoints
% Calculate Enhancement at each timepoint

enhancement = 100.*(double(RawS1(:,:,:))./baseline);

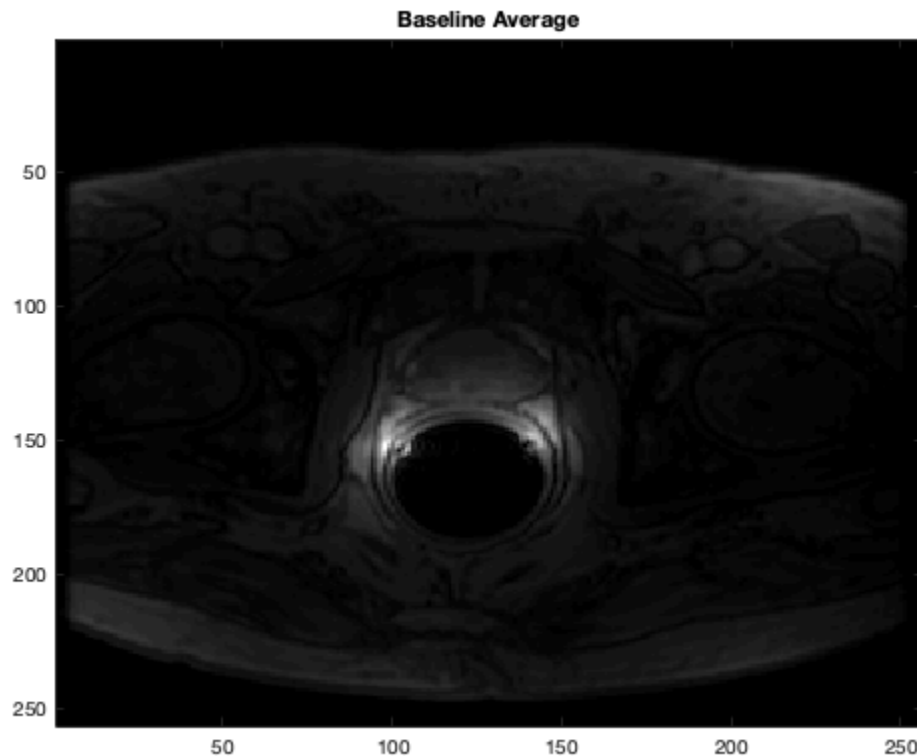
% Calculate the Slope at each timepoint
for i = 2:30
    slope(i,:,:)= enhancement(i,:,:)-enhancement(i-1,:,:);
end

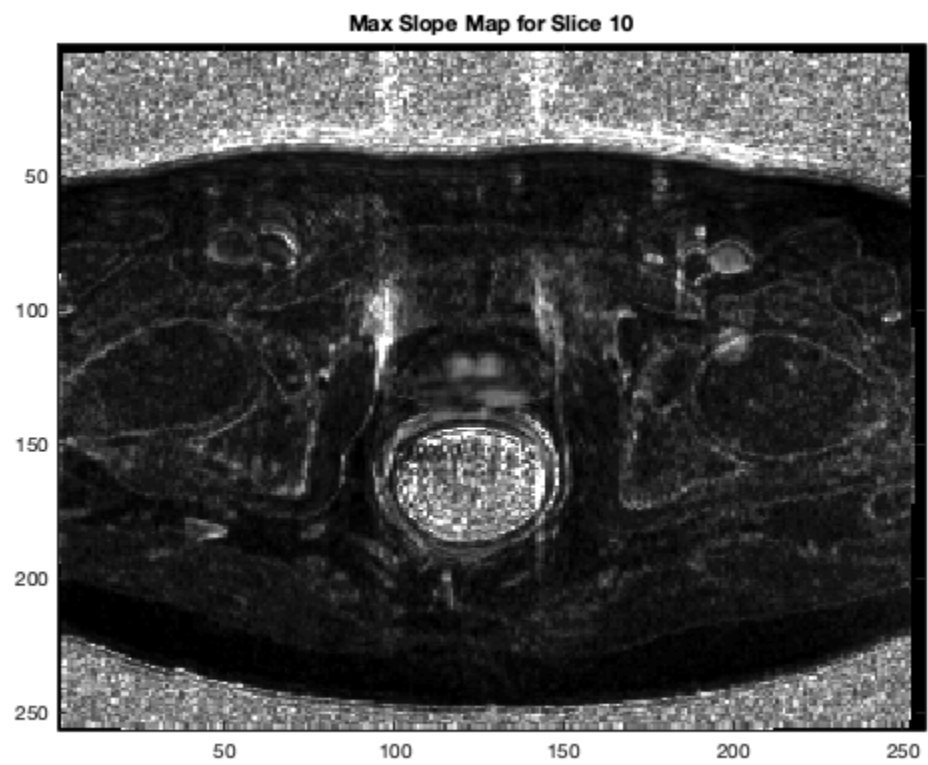
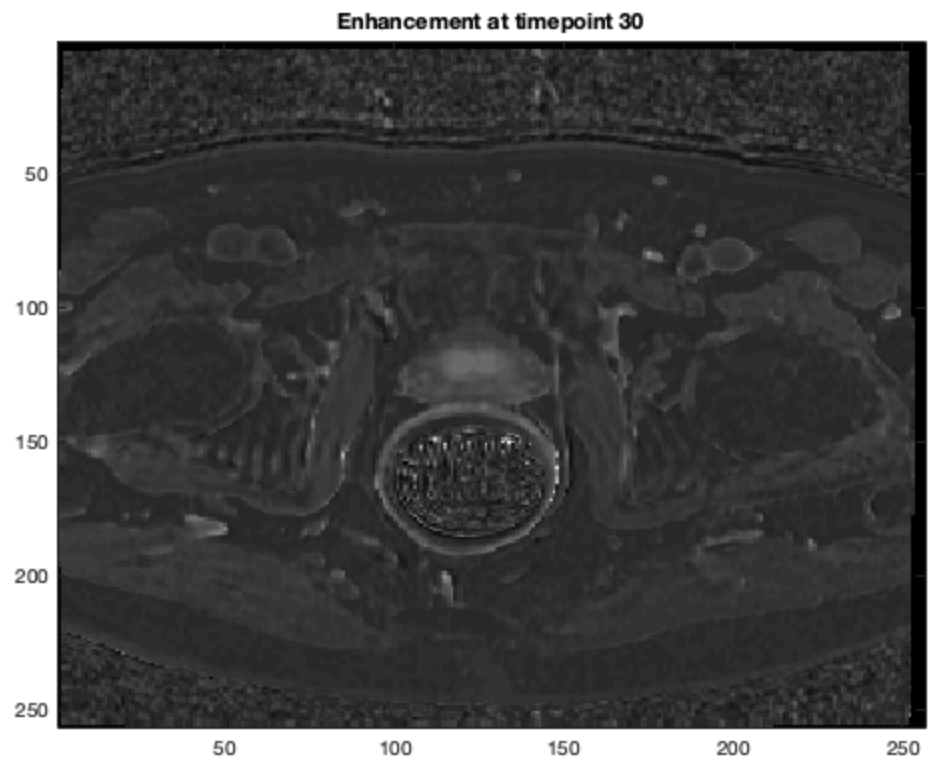
% Calculate the max peak map for the slice
max_peak_map = max(enhancement);
max_peak_map = squeeze(max_peak_map(:,:,:));
% Calculate the max slope map for the slice
max_slope_map = max(slope);
max_slope_map = squeeze(max_slope_map(:,:,:));
```

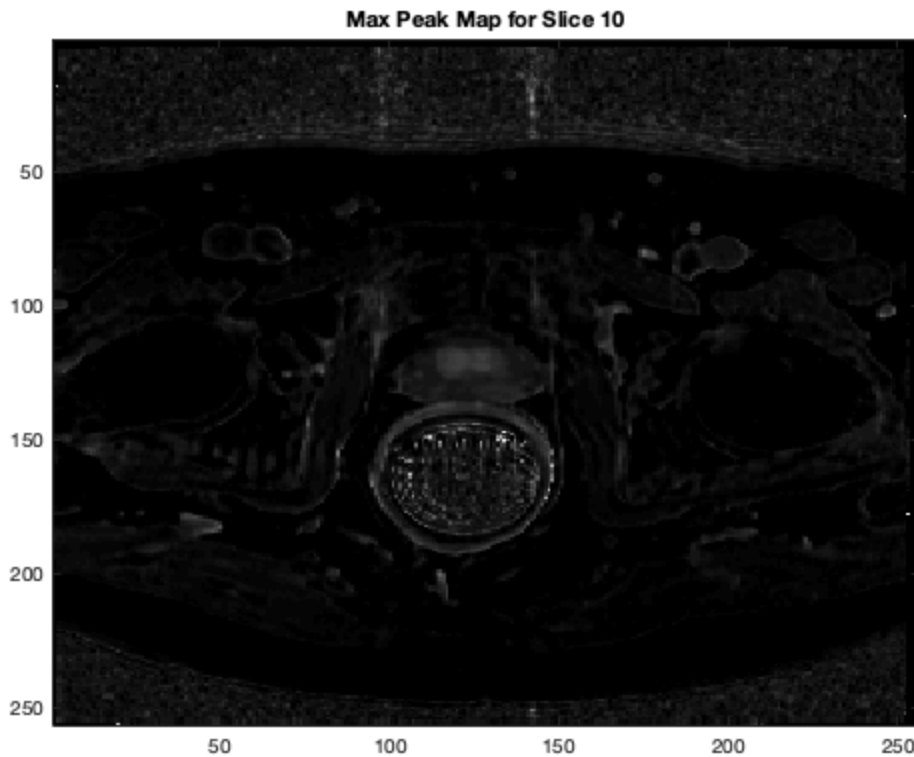
```
% See help for max -- max(3Darray) --> finds the max value across the  
first dimention and saves a 2D array
```

5 - Display Baseline average image, Enhancement Image at timepoint 30, and Parameter Maps for the selected slice

```
close all;  
baseline = squeeze(baseline(:,:,:));  
figure()  
imagesc(baseline); colormap gray  
title('Baseline Average')  
enhancement30 = squeeze(enhancement(30,:,:));  
figure()  
imagesc(enhancement30); colormap gray  
title('Enhancement at timepoint 30')  
figure()  
imagesc(max_slope_map, [0 100]); colormap gray  
title('Max Slope Map for Slice 10')  
figure()  
imagesc(max_peak_map); colormap gray  
title('Max Peak Map for Slice 10')
```





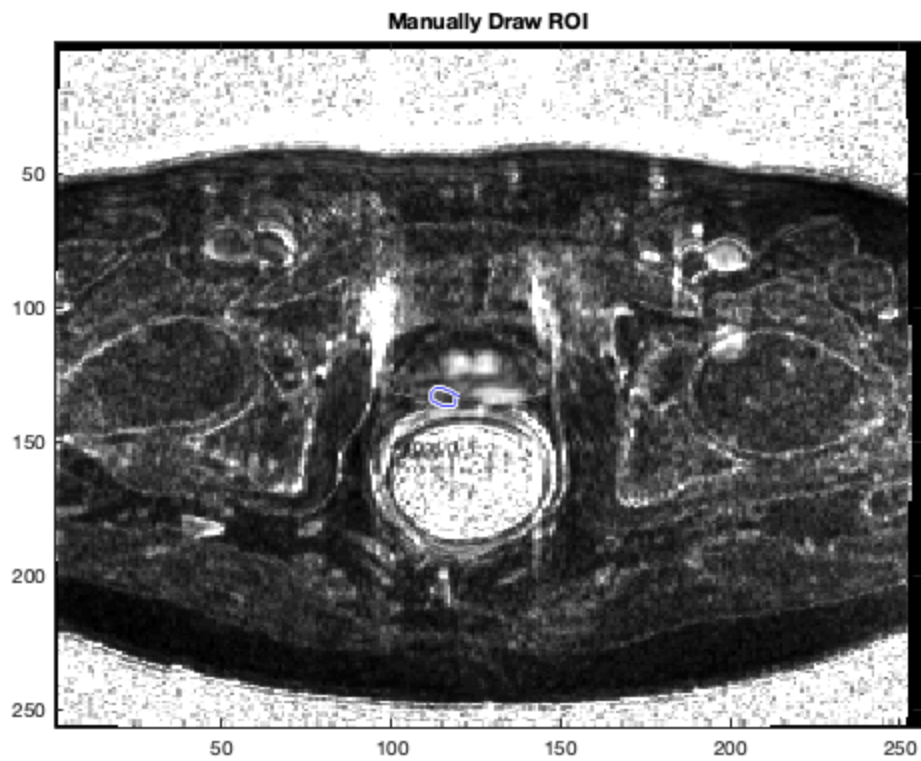


6 - Create Right Peripheral Zone ROI & Left Peripheral Zone ROI -- Compare suspicious region to contralateral side

```
close all;
%Select slice of interest to draw Right and Left Peripheral Zone ROIs

%Manually Draw Patient's Right Peripheral Zone (Image Left)

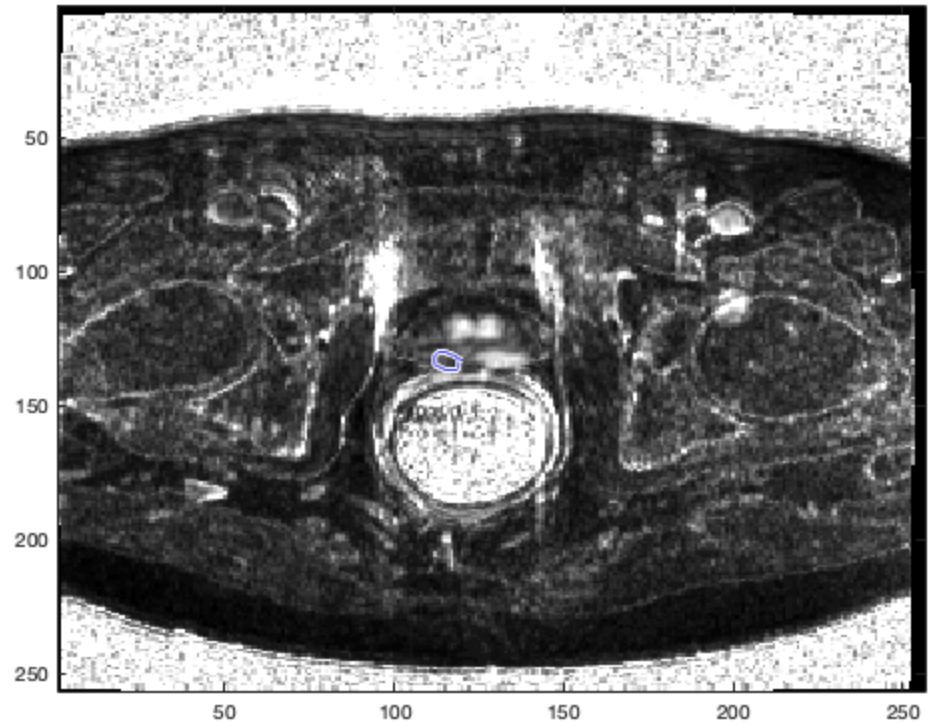
%Display image
figure('name','Max Slope')
imagesc(max_slope_map, [0 50]);
title('Manually Draw ROI');
colormap gray
%Code to draw an ROI
freehandroi=imfreehand(gca);
enhancement_mask_right=createMask(freehandroi);
```



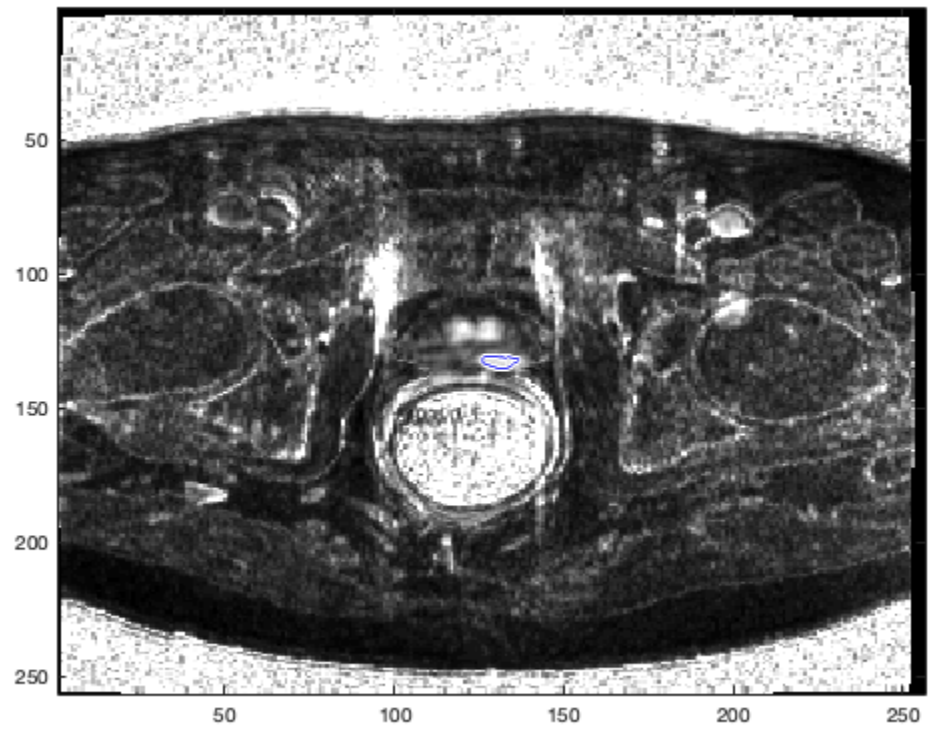
```
%Manually Draw Patient's Left Peripheral Zone (Image Right)
figure('name','Max Slope')
imagesc(max_slope_map,[0 50]);
title('Manually Draw ROI');
colormap gray
%start timing
tic
%Code to draw an ROI
freehandroi=imfreehand(gca);
enhancement_mask_left=createMask(freehandroi);

%-----
```

Manually Draw ROI



Manually Draw ROI



7-Calculate & Display ROI stats

Calculate mean, std, median for Left ROI and Right ROI on Parameter Maps

```
max_peak_map(isnan(max_peak_map))==0;
max_enhancement_map(isnan(max_peak_map))==0;

c = 0;

for i = 1:256
    for j = 1:256
        if enhancement_mask_right(i,j) == 1
            c = c+1;
            right_roi_peak(c)=double(enhancement_mask_right(i,j))...
                .*max_peak_map(i,j);
        end
    end
end

c = 0;
for i = 1:256
    for j = 1:256
        if enhancement_mask_left(i,j) == 1
            c = c+1;
            left_roi_peak(c)=double(enhancement_mask_left(i,j))...
                .*max_peak_map(i,j);
        end
    end
end

c = 0;

for i = 1:256
    for j = 1:256
        if enhancement_mask_right(i,j) == 1
            c = c+1;
            right_roi_slope(c)=double(enhancement_mask_right(i,j))...
                .*max_slope_map(i,j);
        end
    end
end

c = 0;

for i = 1:256
    for j = 1:256
        if enhancement_mask_left(i,j) == 1
            c = c+1;
            left_roi_slope(c)=double(enhancement_mask_left(i,j))...
                .*max_slope_map(i,j);
        end
    end
end

mean_right_peak=nanmean(mean(right_roi_peak))
```

```
mean_left_peak= nanmean(mean(left_roi_peak))
median_right_peak = nanmedian(median(right_roi_peak))
median_left_peak = nanmedian(median(left_roi_peak))
std_right_peak = nanstd(std(right_roi_peak))
std_left_peak =nanstd(std(left_roi_peak))

mean_right_slope=nanmean(mean(right_roi_slope))
mean_left_slope= nanmean(mean(left_roi_slope))
median_right_slope = nanmedian(median(right_roi_slope))
median_left_slope = nanmedian(median(left_roi_slope))
std_right_slope = nanstd(std(right_roi_slope))
std_left_slope =nanstd(std(left_roi_slope))
```

```
mean_right_peak =
```

```
162.6157
```

```
mean_left_peak =
```

```
172.4553
```

```
median_right_peak =
```

```
161.0662
```

```
median_left_peak =
```

```
172.2086
```

```
std_right_peak =
```

```
0
```

```
std_left_peak =
```

```
0
```

```
mean_right_slope =
```

```
16.4568
```

```
mean_left_slope =
```

```
43.6284
```

```
median_right_slope =
```

```
17.0161
```

```
median_left_slope =
```

```
43.6281
```

```
std_right_slope =
```

```
0
```

```
std_left_slope =
```

```
0
```

8- Plot uptake curves vs. time in seconds

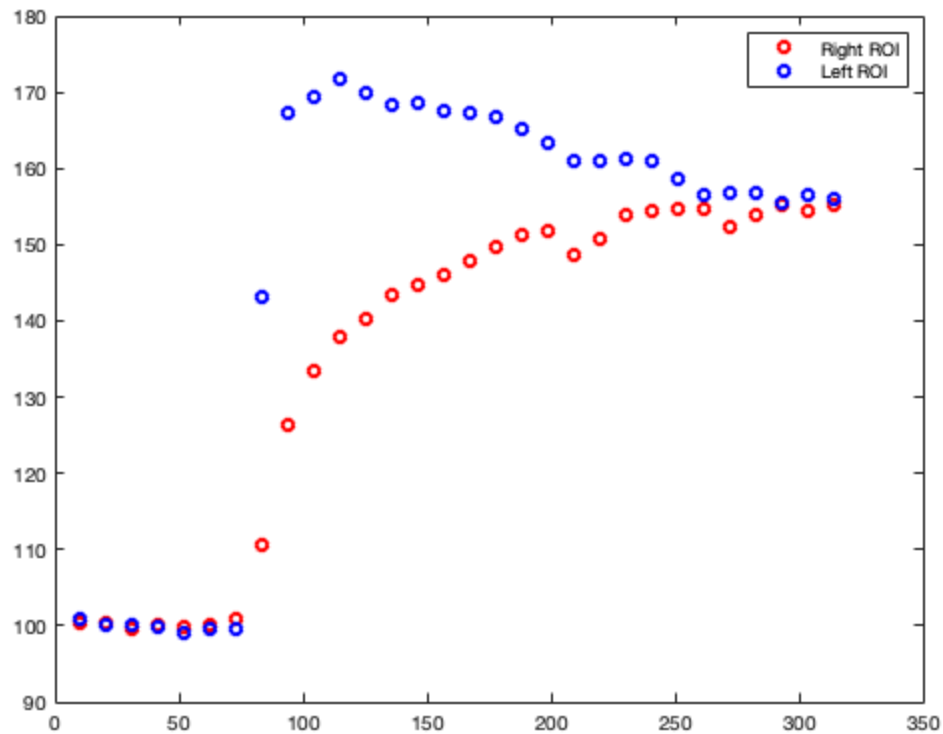
```
%Set x-axis values in sec
t = tempres.*[1:30];
%Calculate mean ROI vs. time
mean_roi_right= zeros(1,30);

mean_roi_right=zeros(1,30);
mean_roi_left = zeros(1,30);
for i = 1:30
    enhancement_2d=squeeze(enhancement(i,:,:));
    overlay_right= enhancement_2d(enhancement_mask_right);
    overlay_left= enhancement_2d(enhancement_mask_left);
    mean_roi_right(:,i)=mean(overlay_right);
    mean_roi_left(:,i)=mean(overlay_left);
end

close all
% mean enhancement on y axis, time on x axis

%Plot both curves - see plot, hold on, legend

plot(t, mean_roi_right,'or')
hold on
plot(t, mean_roi_left,'ob')
legend('Right ROI','Left ROI')
```



9 - Calculate Washout Slope for the 2 ROIs as a linear fit to the last half of the timepoints

```
%create x vector
xvec = tempres.*[16:30];
%create y vector of the same size
yvec_right = mean_roi_right(16:30);
yvec_left = mean_roi_left(16:30);
p_right = polyfit(xvec, yvec_right,1); %first order polynomial: y =
    mx + b format
rwo_slope = p_right(1);
p_left = polyfit(xvec, yvec_left,1); %first order polynomial: y = mx
    + b format
lwo_slope = p_left(1);

% Put in units of %baseline / minute

rwo_slope = rwo_slope*60
lwo_slope = lwo_slope*60

%-----

rwo_slope =
```

2.6101

lwo_slope =

-4.8796

- Reset directory out of data folder

```
cd ../../..
```

- Answer Questions from Lab Handout

1. Cancer is most likely on patient's left. The left ROI had a steep upslope and a washout while the right enhancement increased more slowly and kept increasing. 2. High grade, because the steeper slope means more permeability and higher peak enhancement means more washout of extracellular extracellular space. 3. a) Not easy from baseline, image does not have much contrast difference. b) Not from enhancement at timepoint 30 either. c) Not max peak map. d) Max slope map has contrast difference. e) Very clear from the curves. 4. Getting the right brightness and contrast is challenging. You also need to know the appropriate T1 and T2 to get that contrast in DCE in an appropriate time frame. 5. Getting the right contrast is crucial for viewing the cancer. Weighting the max slope image with the T2 to get even better contrast. Measurements could be more accurate with better selection of region of interest using that contrast.

Published with MATLAB® R2018b