Core Tasks

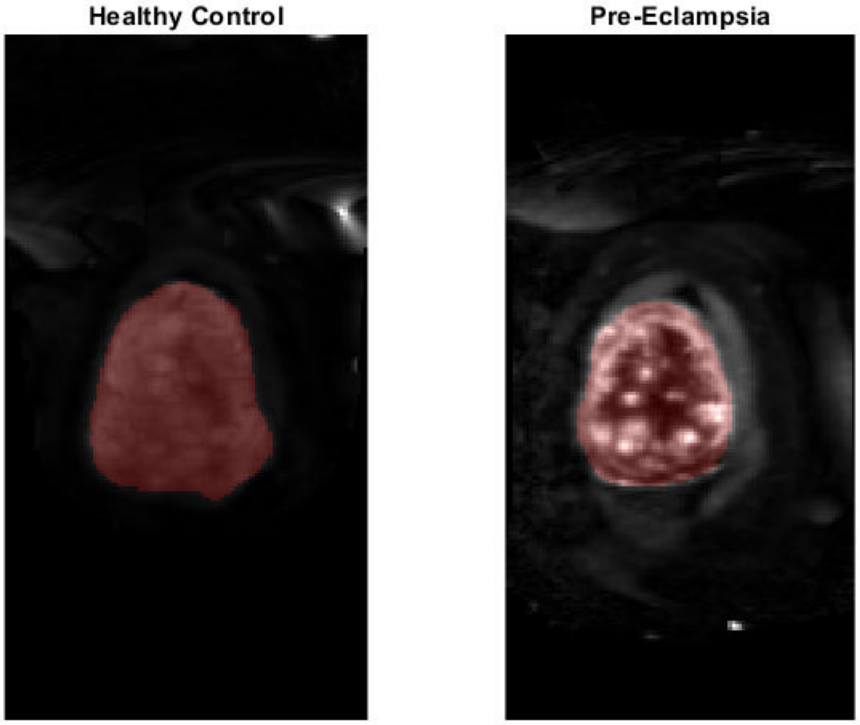
Github repo (https://github.com/simonEllershaw/COMP0118GroupProject)

Task 1- Load and plot the MRI volumes and masks

```
loadData
```

Visualise slice and mask of 1st healthy and pre-eclampsia sample

```
slice_num = 7;
figure();
subplot(1,2,1)
Plotter.visualise_slice(V_healthy(:,:,slice_num,1), M_healthy_placenta_uterine_wall(:,:,slice_
subplot(1,2,2)
Plotter.visualise_slice(V_pre_eclampsia(:,:,slice_num,1), M_pre_eclampsia_placenta_uterine_wal
```



Task 2- Load and plot the MRI acquisition parameters

Each row of MRI params associated with sample from volume

```
size(grad_echo)
```

```
ans = 1×2
   330     5
```

```
size(V_healthy)
```

```
ans = 1×4
   200   106    30   330
```

```
unique_b_values_number = numel(unique(grad_echo(:,4)))
```

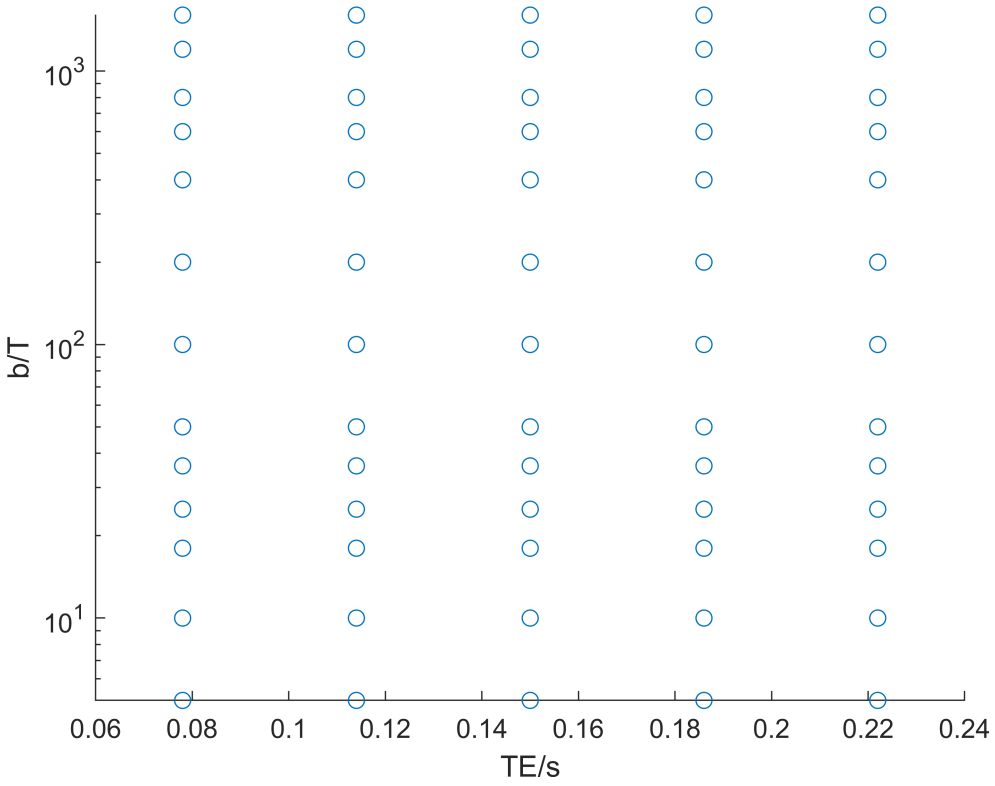
```
unique_b_values_number = 14
```

```
unique_echo_times_number = numel(unique(grad_echo(:,5)))
```

```
unique_echo_times_number = 5
```

Visualise MRI params

```
x = grad_echo(:,5);
y = grad_echo(:,4);
figure();
scatter(x,y);
set(gca, 'YScale', 'log')
xlabel("TE/s");
ylabel("b/T");
```



Task 3- Fit combined T2*-ADC model

Init objects

```
model = T2ADCModel();
non_lin_optimiser = NonLinearOptimiser();
```

Single voxel single run fit

Fit model to single voxel of healthy data

```
non_zero_voxels = reshape(nonzeros(ROI_healthy_placenta_uterine_wall), [], num_scans);
sample_voxel = non_zero_voxels(1, :)';
start_params_T2ADC = [100 0.01 0.001];
start_params_constr_space = T2ADCModel.to_constr_space(start_params_T2ADC);

[params_contr, SSD] = non_lin_optimiser.model_to_voxel(@model.predict, sample_voxel, bvals, TE,
```

Print parameters

```
params_fitted = T2ADCModel.to_param_space(params_contr)
```

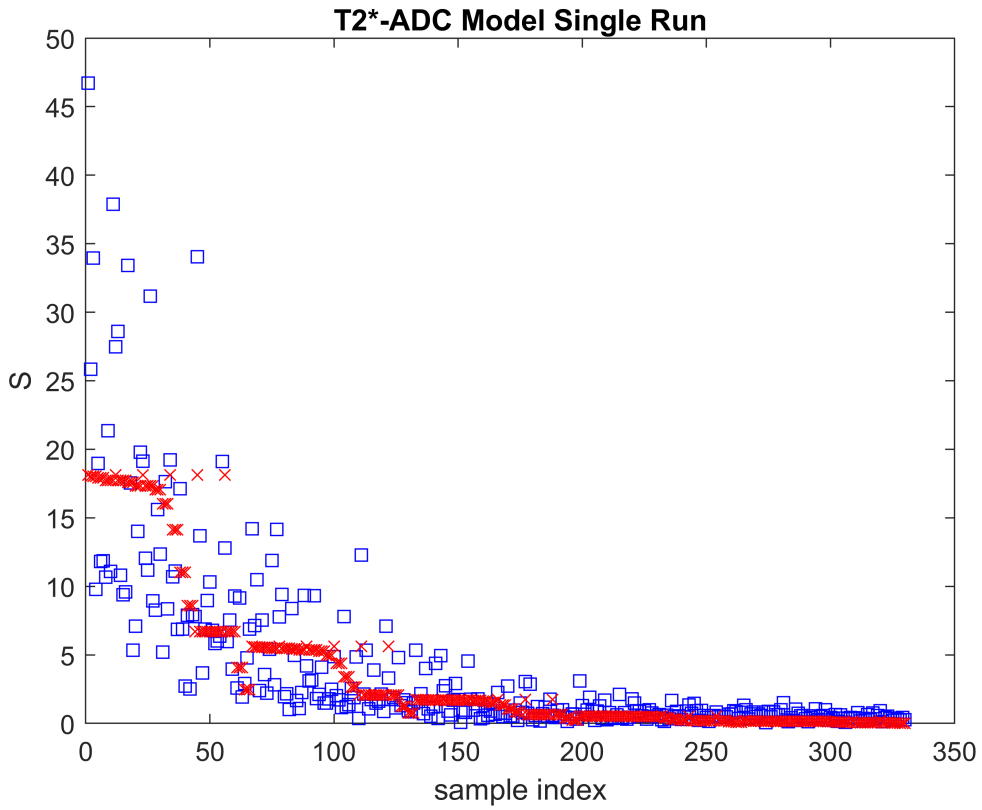
```
params_fitted = 1×3
  230.3270    0.0307    0.0012
```

```
SSD
```

```
SSD = 4.8936e+03
```

Visualise fit

```
S_predicted = model.predict(params_contr, bvals, TE);
figure();
visualise_model_voxel_fit(S_predicted, sample_voxel, "T2*-ADC Model Single Run")
```



Constrained Single voxel multi run fit

```
pertubation_sigmas_constr_space = T2ADCModel.to_constr_space([50 0.01 0.001]);
[sorted_SSD, sorted_parameters] = non_lin_optimiser.multirun_exploritory(model, sample_voxel, b
```

Print model parameters

```
parameters = T2ADCModel.to_param_space(sorted_parameters(1, :))
```

```
parameters = 1×3
  230.3251    0.0307    0.0012
```

```
SSD = sorted_SSD(1)
```

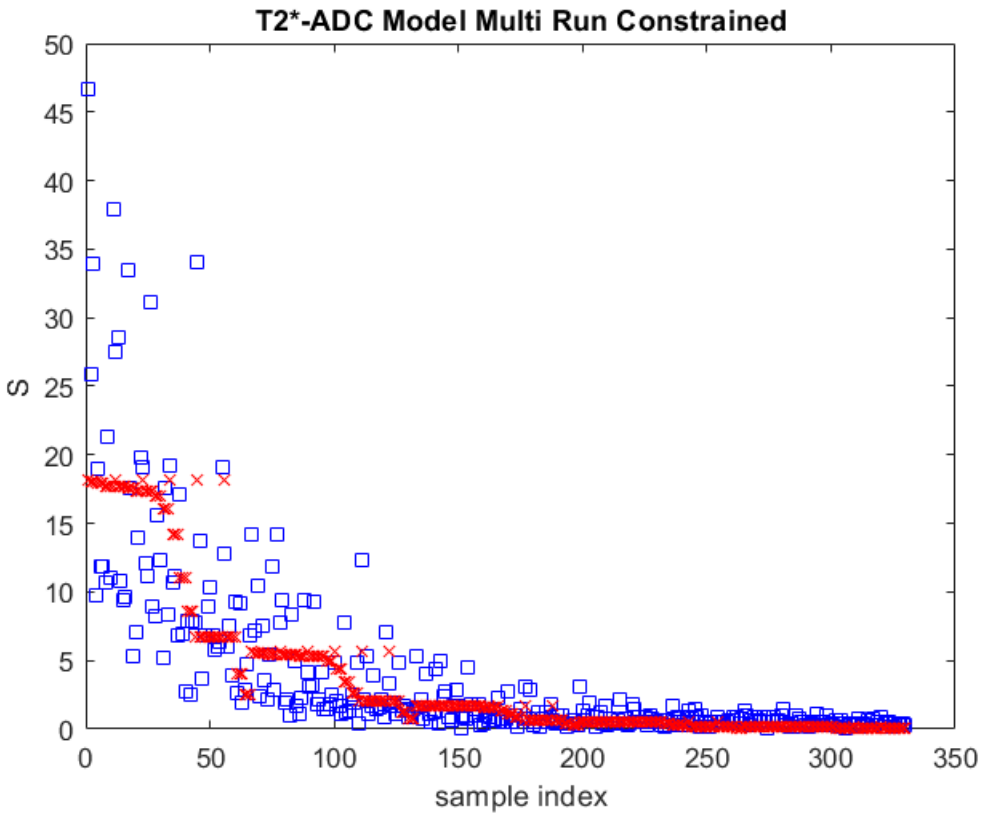
```
SSD = 4.8936e+03
```

```
numRuns = num_runs_to_get_min_95_percent_time(sorted_SSD)
```

```
occurance_min = 0.5600
numRuns = 3.6490
```

Visualise fit

```
best_fit = model.predict(sorted_parameters(1, :), bvals, TE);
visualise_model_voxel_fit(best_fit, sample_voxel, "T2*-ADC Model Multi Run Constrained");
```



Fit Pre Healthy Placenta with Uterine Wall (Single Slice)

Run fit

```
num_loops = 5; % Set based of previous experiments
slice_of_interest_h_uw = ROI_healthy_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_h_uw_T2ADC, best_SSD_map_h_uw_T2ADC] = non_lin_optimiser.slice_multi_run(model,
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Healthy Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_h = ROI_healthy_placenta(:,:,slice_num, :);
[parameter_map_h_T2ADC, best_SSD_map_h_T2ADC] = non_lin_optimiser.slice_multi_run(model, slice_
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Pre Exclampsia Placenta with Uterine Wall (Single Slice)

```
slice_of_interest_pe_uw = ROI_pre_eclampsia_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_pe_uw_T2ADC, best_SSD_map_pe_uw_T2ADC] = non_lin_optimiser.slice_multi_run(model
```

```
row_num = 10
row_num = 20
```

```
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Pre Exclampsia Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_pe = ROI_pre_eclampsia_placenta(:,:,slice_num, :);
[parameter_map_pe_T2ADC, best_SSD_map_pe_T2ADC] = non_lin_optimiser.slice_multi_run(model, slic
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Task 4- Visualise and Compare Healthy and Pre-Eclampsia Maps

Combine all maps into a single 4D array

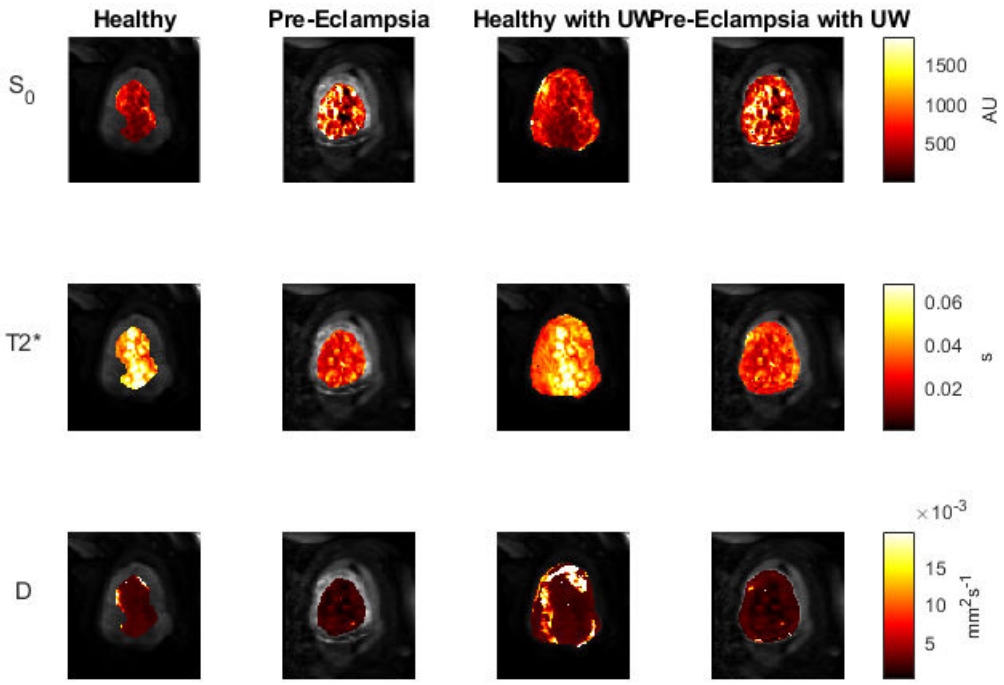
```
num_maps = 4;
param_maps_T2ADC=zeros([num_maps, size(parameter_map_h_T2ADC)]);
param_maps_T2ADC(1,:,:,:) = parameter_map_h_T2ADC(:,:,:);
param_maps_T2ADC(2,:, 1:size(parameter_map_pe_T2ADC,2), 1:size(parameter_map_pe_T2ADC,3)) = par
param_maps_T2ADC(3,:,:,:) = parameter_map_h_uw_T2ADC(:,:,:);
param_maps_T2ADC(4,:, 1:size(parameter_map_pe_uw_T2ADC,2), 1:size(parameter_map_pe_uw_T2ADC,3))
```

Define labels for plot

```
param_labels = ["S_0", "T2*", "D"];
map_labels = ["Healthy", "Pre-Eclampsia", "Healthy with UW", "Pre-Eclampsia with UW"];
param_units = ["AU", "s", "mm^2s^{-1}"];
```

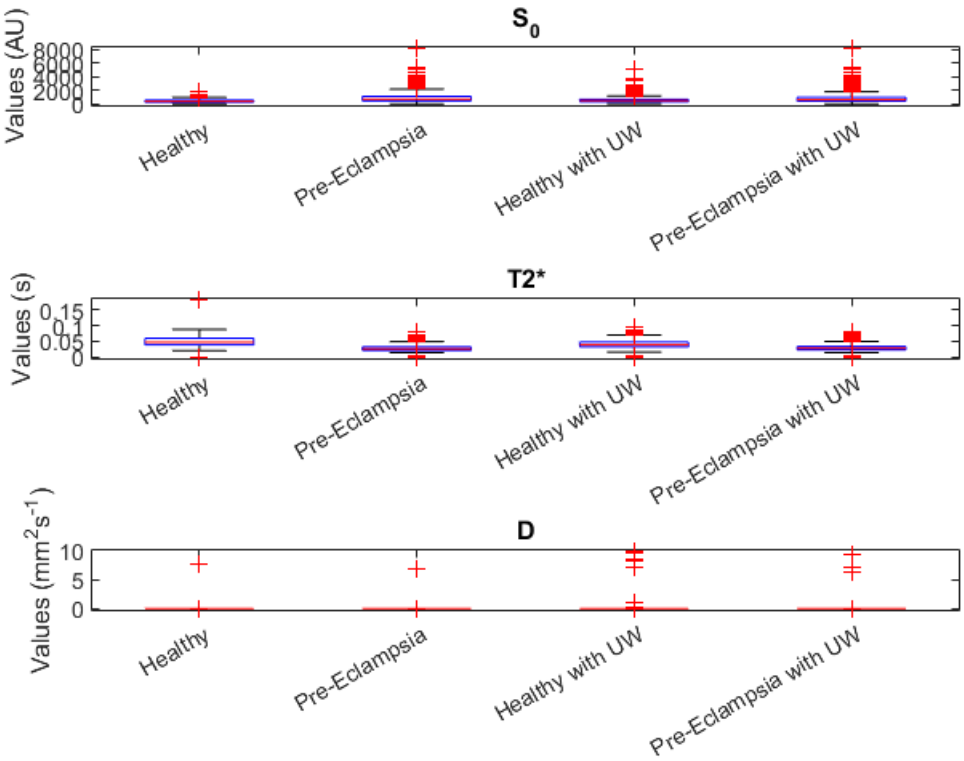
Plot maps

```
figure();
Plotter.visualise_param_maps(param_maps_T2ADC, squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_p
```



Plot box plots of parameters

```
figure();
Plotter.box_plot_param_maps(param_maps_T2ADC, param_labels, map_labels, param_units)
```

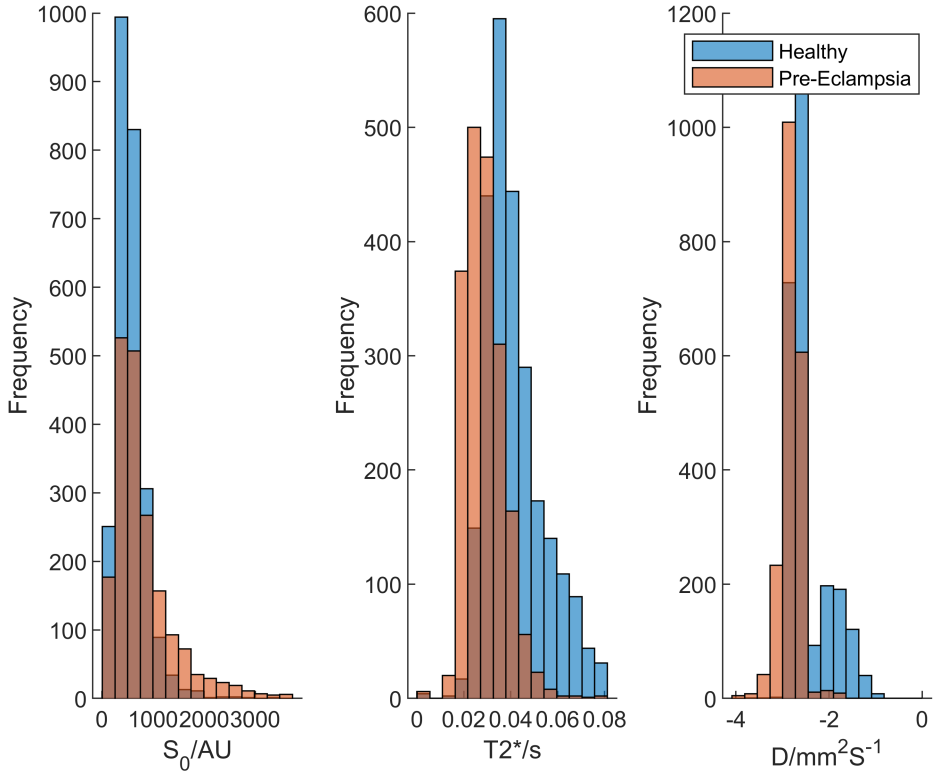


Move D parameters into log space

```
param_maps_T2ADC_log = param_maps_T2ADC;
param_maps_T2ADC_log(:,3, :, :) = log10(param_maps_T2ADC_log(:,3, :, :));
param_maps_T2ADC_log(param_maps_T2ADC_log<-5) = 0;
```

Histogram of paramter distribution for each scan inlcuding uterine wall

```
figure();
map_labels = ["Healthy", "Pre-Eclampsia"];
param_labels = ["S_0/AU", "T2*/s", "D/mm^2S^{-1}"];
Plotter.histogram_param_maps(param_maps_T2ADC_log(3:4,:,:,:), param_labels, map_labels)
```



Task 5- IVIM Model

```
model = IVIMModel();
```

Single voxel single run fit

Fit model to single voxel of healthy data

```
start_params_IVIM = [100 0.01 0.01 0.5 0.001];
start_params_constr_space = IVIMModel.to_constr_space(start_params_IVIM);
[params_contr, SSD] = non_lin_optimiser.model_to_voxel(@model.predict, sample_voxel, bvals, TE,
```

Print parameters

```
params_fitted = IVIMModel.to_param_space(params_contr)
```

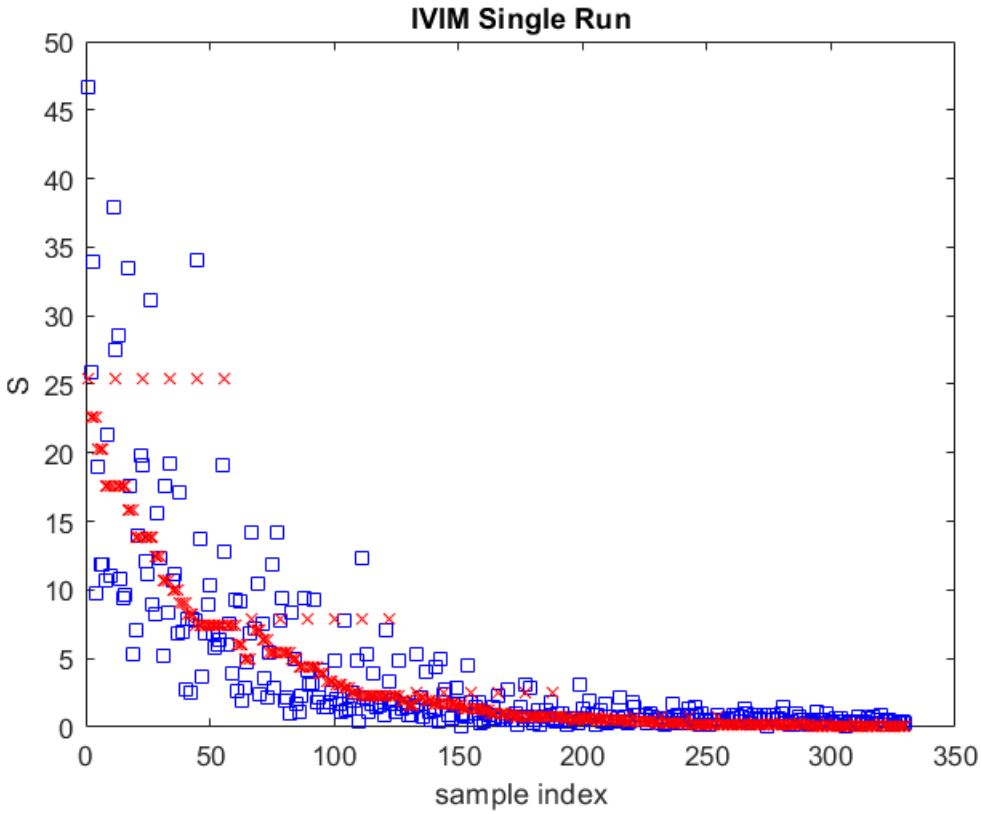
```
params_fitted = 1×5
  318.2489    0.0308    0.0433    0.5637    0.0005
```

```
SSD
```

```
SSD = 4.0746e+03
```

Visualise fit

```
S_predicted = model.predict(params_contr, bvals, TE);
figure();
visualise_model_voxel_fit(S_predicted, sample_voxel, "IVIM Single Run")
```



Constrained Single voxel multi run fit

```
pertubation_sigmas_constr_space = IVIMModel.to_constr_space([50 0.01 0.01 0.1 0.001]);
[sorted_SSD, sorted_parameters] = non_lin_optimiser.multirun_exploritory(model, sample_voxel, b
```

Print model parameters

```
parameters = IVIMModel.to_param_space(sorted_parameters(1, :))
```

```
parameters = 1×5
  318.2479    0.0308    0.0433    0.5637    0.0005
```

```
SSD = sorted_SSD(1)
```

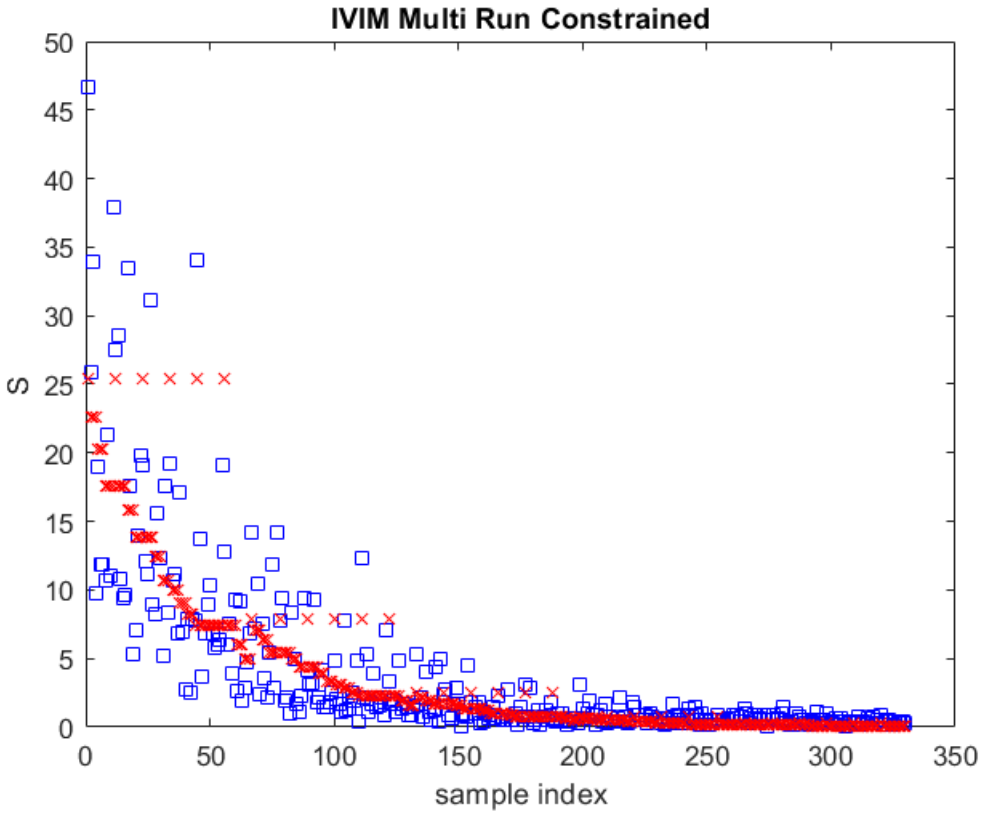
```
SSD = 4.0746e+03
```

```
numRuns = num_runs_to_get_min_95_percent_time(sorted_SSD)
```

```
occurance_min = 0.6500
numRuns = 2.8536
```

Visualise fit

```
best_fit = model.predict(sorted_parameters(1, :), bvals, TE);
visualise_model_voxel_fit(best_fit, sample_voxel, "IVIM Multi Run Constrained");
```



Fit Pre Healthy Placenta with Uterine Wall (Single Slice)

Run fit

```
slice_of_interest_h_uw = ROI_healthy_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_h_uw_IVIM, best_SSD_map_h_uw_IVIM] = non_lin_optimiser.slice_multi_run(model, sl
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Healthy Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_h = ROI_healthy_placenta(:,:,slice_num, :);
```

```
[parameter_map_h_IVIM, best_SSD_map_h_IVIM] = non_lin_optimiser.slice_multi_run(model, slice_of
```

Fit Pre Exclampsia Placenta with Uterine Wall (Single Slice)

```
slice_of_interest_pe_uw = ROI_pre_eclampsia_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_pe_uw_IVIM, best_SSD_map_pe_uw_IVIM] = non_lin_optimiser.slice_multi_run(model,
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Pre Exclampsia Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_pe = ROI_pre_eclampsia_placenta(:,:,slice_num, :);
[parameter_map_pe_IVIM, best_SSD_map_pe_IVIM] = non_lin_optimiser.slice_multi_run(model, slice_
```

Combine all maps into a single 4D array

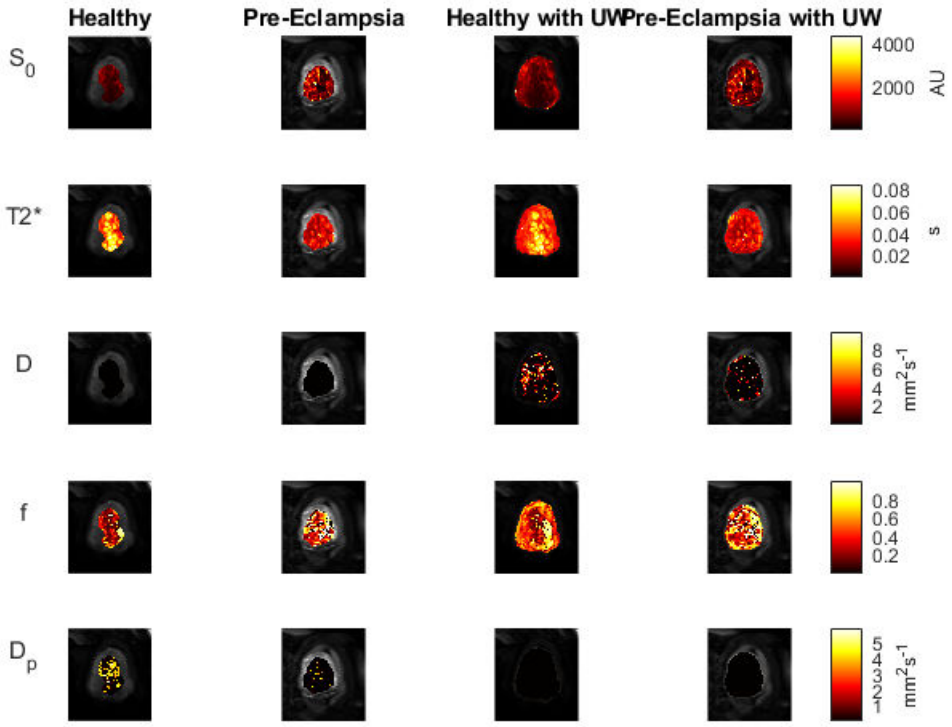
```
param_maps_IVIM=zeros([4, size(parameter_map_h_IVIM)]);
param_maps_IVIM(1,:,:,:) = parameter_map_h_IVIM(:,:,:);
param_maps_IVIM(2,:, 1:size(parameter_map_pe_IVIM,2), 1:size(parameter_map_pe_IVIM,3)) = parame
param_maps_IVIM(3,:,:,:) = parameter_map_h_uw_IVIM(:,:,:);
param_maps_IVIM(4,:, 1:size(parameter_map_pe_uw_IVIM,2), 1:size(parameter_map_pe_uw_IVIM,3)) =
```

Define labels for plot

```
param_labels = ["S_0", "T2*", "D", "f", "D_p"];
map_labels = ["Healthy", "Pre-Eclampsia", "Healthy with UW", "Pre-Eclampsia with UW"];
param_units = ["AU", "s", "mm^2s^{-1}", "", "mm^2s^{-1}"];
```

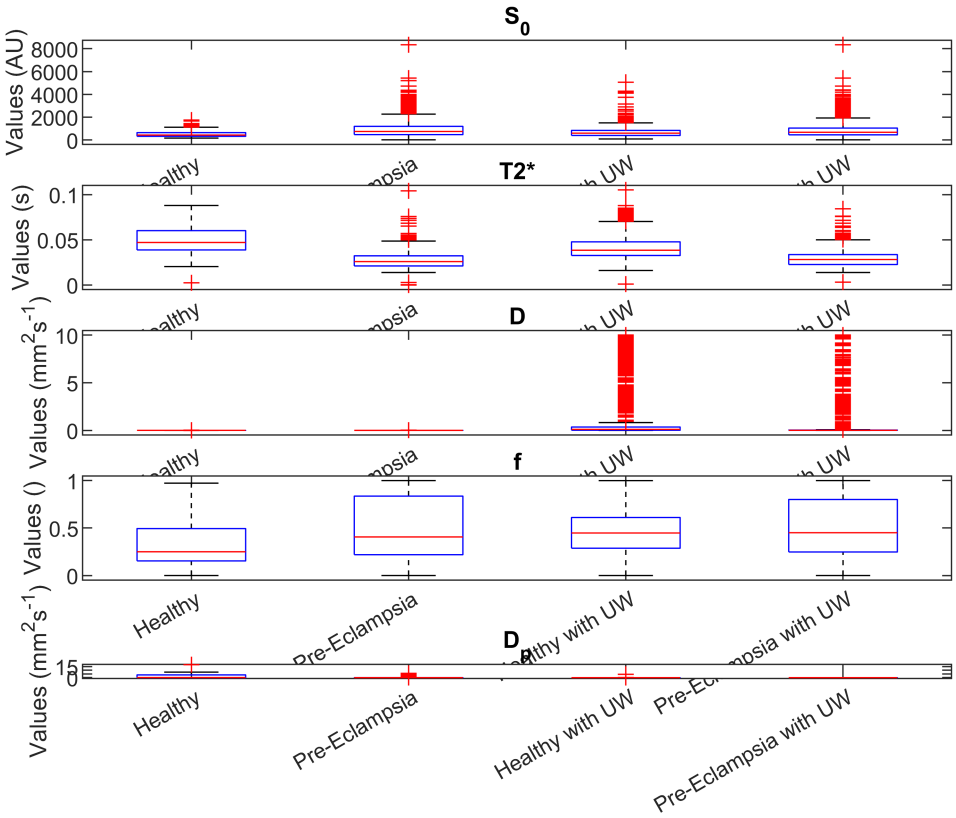
Plot maps

```
figure();
tiledlayout(size(param_maps_IVIM,2),num_maps);
Plotter.visualise_param_maps(param_maps_IVIM, squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_pr
```



Plot box plots of parameters

```
figure();
Plotter.box_plot_param_maps(param_maps_IVIM, param_labels, map_labels, param_units)
```



Task 7- Continuum Model

Setup

```
T2_values = linspace(0.0, 0.1, 50);
D_values = logspace(-3, 1, 50);
ROI = ROI_healthy_placenta_uterine_wall;
```

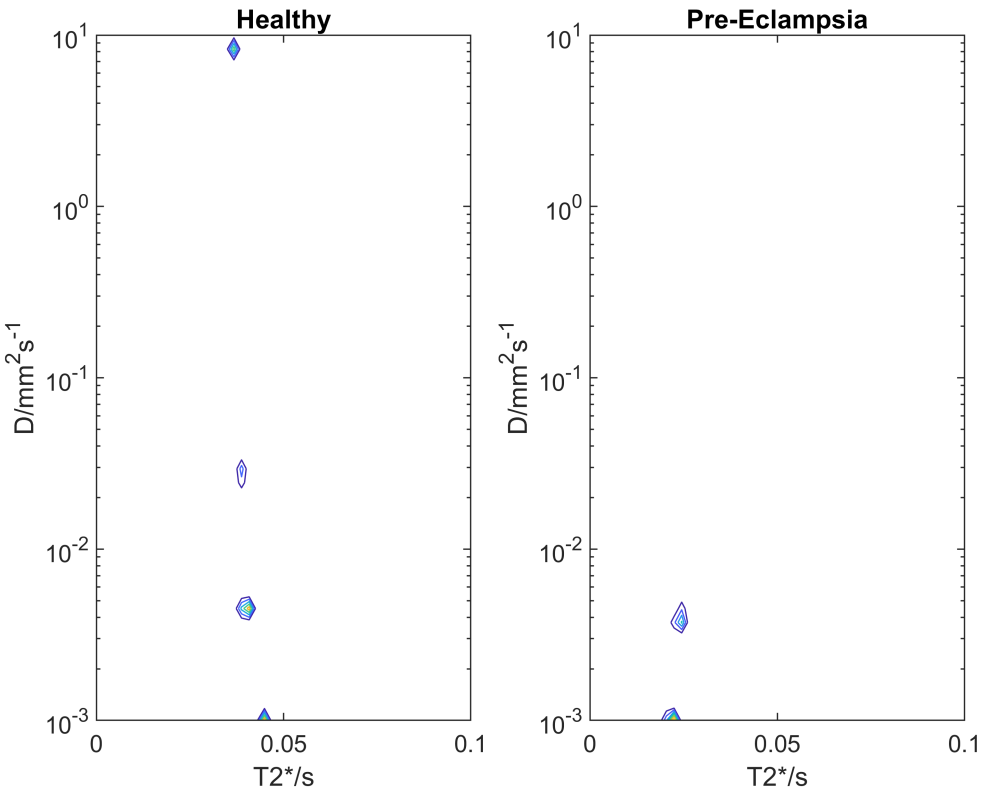
Calc and plot healthy spectrum

```
spectrum = ContinuumModel.calc_spectrum(T2_values, D_values, ROI, bvals, TE);
figure();
subplot(1,2,1)
contour(T2_values, D_values, spectrum)
title("Healthy")
xlabel("T2*/s")
ylabel("D/mm^2s^{-1}")
set(gca, 'YScale', 'log')
```

Calc and plot pre-eclampsia spectrum

```
ROI = ROI_pre_eclampsia_placenta_uterine_wall;
spectrum = ContinuumModel.calc_spectrum(T2_values, D_values, ROI, bvals, TE);
subplot(1,2,2)
```

```
contour(T2_values, D_values, spectrum)
xlabel("T2*/s")
ylabel("D/mm^2s^{-1}")
title("Pre-Eclampsia")
set(gca, 'YScale', 'log')
```



Task 8- Three Compartment Model

```
model = ThreeCompModel();
```

Single voxel single run fit

Fit model to single voxel of healthy data

```
start_params_3_Comp = [100 0.01 0.1 0.5 0.01 0.5 0.001];
start_params_constr_space = ThreeCompModel.to_constr_space(start_params_3_Comp);
[params_contr, SSD] = non_lin_optimiser.model_to_voxel(@model.predict, sample_voxel, bvals, TE
```

Print parameters

```
params_fitted = ThreeCompModel.to_param_space(params_contr)
```

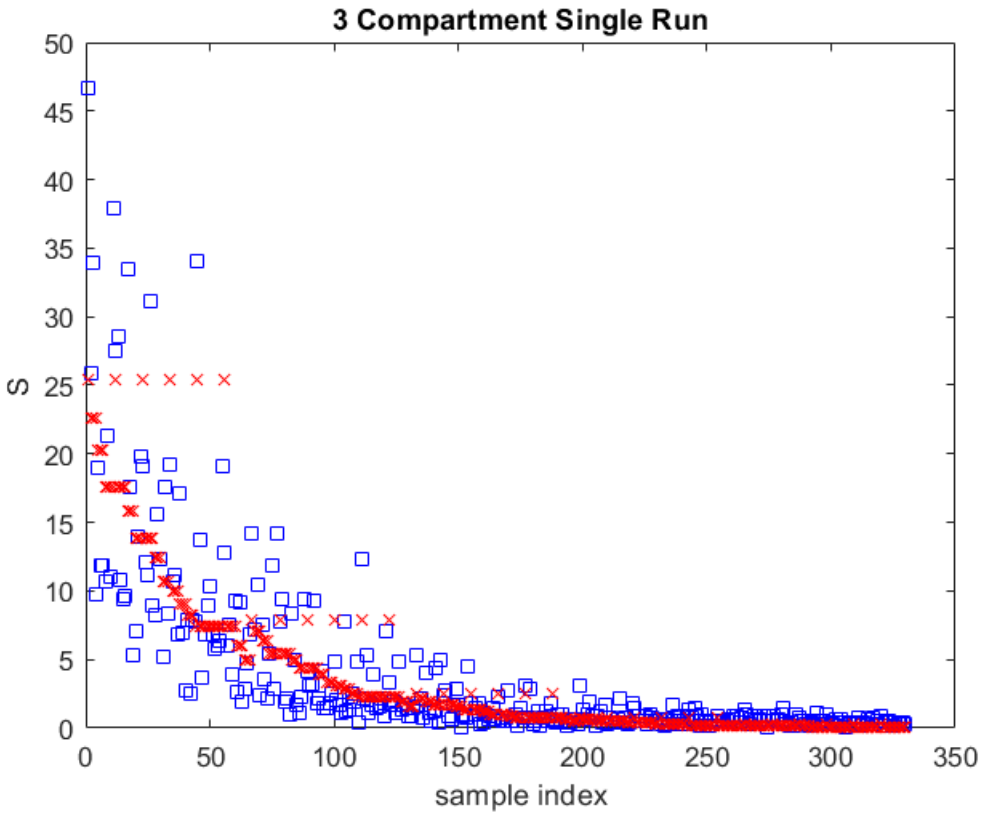
```
params_fitted = 1×7
  318.2498    0.0308    0.0433    0.5637    0.0005    1.0000    0.0002
```

```
SSD
```

```
SSD = 4.0746e+03
```

Visualise fit

```
S_predicted = model.predict(params_contr, bvals, TE);
figure();
visualise_model_voxel_fit(S_predicted, sample_voxel, "3 Compartment Single Run")
```



Constrained Single voxel multi run fit

```
pertubation_sigmas_constr_space = abs(ThreeCompModel.to_constr_space([50 0.01 0.1 0.1 0.001 0.1
```

```
pertubation_sigmas_constr_space = 1×7
    7.0711    0.1002    0.0997    0.3218    0.0315    0.3218    0.0316
```

```
[sorted_SSD, sorted_parameters] = non_lin_optimiser.multirun_exploritory(model, sample_voxel, b
```

Print model parameters

```
parameters = ThreeCompModel.to_param_space(sorted_parameters(1, :))
```

```
parameters = 1×7
  334.1938    0.0308    0.2828    0.2207    0.0230    0.5084    0.0004
```

```
SSD = sorted_SSD(1)
```

```
SSD = 4.0296e+03
```

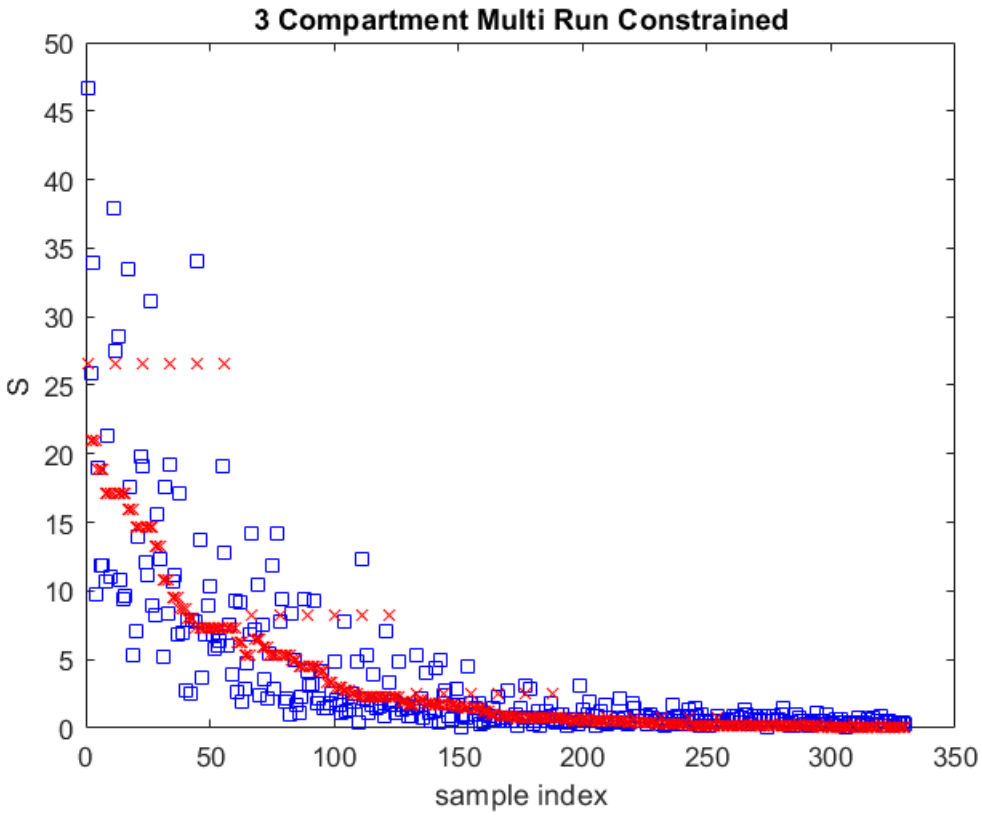
```
numRuns = num_runs_to_get_min_95_percent_time(sorted_SSD)
```

```
occurance_min = 0.5500
```

```
numRuns = 3.7517
```

Visualise fit

```
best_fit = model.predict(sorted_parameters(1, :), bvals, TE);
visualise_model_voxel_fit(best_fit, sample_voxel, "3 Compartment Multi Run Constrained");
```



Fit Pre Healthy Placenta with Uterine Wall (Single Slice)

Run fit

```
slice_of_interest_h_uw = ROI_healthy_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_h_uw_3_comp, best_SSD_map_h_uw_3_comp] = non_lin_optimiser.slice_multi_run(model
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
```

```
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Healthy Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_h = ROI_healthy_placenta(:,:,slice_num, :);
[parameter_map_h_3_comp, best_SSD_map_h_3_comp] = non_lin_optimiser.slice_multi_run(model, slic
```

Fit Pre Exclampsia Placenta with Uterine Wall (Single Slice)

```
slice_of_interest_pe_uw = ROI_pre_eclampsia_placenta_uterine_wall(:,:,slice_num, :);
[parameter_map_pe_uw_3_comp, best_SSD_map_pe_uw_3_comp] = non_lin_optimiser.slice_multi_run(mod
```

```
row_num = 10
row_num = 20
row_num = 30
row_num = 40
row_num = 50
row_num = 60
row_num = 70
row_num = 80
row_num = 90
row_num = 100
row_num = 110
row_num = 120
row_num = 130
row_num = 140
row_num = 150
row_num = 160
row_num = 170
row_num = 180
row_num = 190
row_num = 200
```

Fit Pre Exclampsia Placenta with no Uterine Wall (Single Slice)

```
slice_of_interest_pe = ROI_pre_eclampsia_placenta(:,:,slice_num, :);
[parameter_map_pe_3_comp, best_SSD_map_pe_3_comp] = non_lin_optimiser.slice_multi_run(model, sl
```

Visulise 3-Compartment parameter maps

Combine all maps into a single 4D array

```
param_maps_3_comp=zeros([4, size(parameter_map_h_uw_3_comp, 1), size(parameter_map_h_uw_3_comp,
param_maps_3_comp(1,:,:,:) = parameter_map_h_3_comp(:,:,:);
param_maps_3_comp(2,:, 1:size(parameter_map_pe_3_comp,2), 1:size(parameter_map_pe_3_comp,3)) =
param_maps_3_comp(3,:,:,:) = parameter_map_h_uw_3_comp(:,:,:);
param_maps_3_comp(4,:, 1:size(parameter_map_pe_uw_3_comp,2), 1:size(parameter_map_pe_uw_3_comp,
```

Define labels for plot

```
param_labels = ["S_0", "T2*", "D_1", "f_1", "D_2", "v", "D_3"];
map_labels = ["Healthy", "Pre-Eclampsia", "Healthy with UW", "Pre-Eclampsia with UW"];
param_units = ["AU", "s", "mm^2s^{-1}", "", "mm^2s^{-1}", "", "mm^2s^{-1}"];
```

Plot maps

```
figure();
tiledlayout(size(param_maps_3_comp,2),num_maps);
Plotter.visualise_param_maps(param_maps_3_comp, squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_
```

Plot box plots of parameters

```
figure();
Plotter.box_plot_param_maps(param_maps_3_comp, param_labels, map_labels, param_units)
```

Visualise parameter maps across all maps

```
num_models = 3;
param_maps_all=zeros([num_models*2, size(parameter_map_h_uw_3_comp, 1), size(parameter_map_h_uw
% Load T2*-ADC
param_maps_all(1,1:size(parameter_map_h_uw_T2ADC,1),:,:) = parameter_map_h_uw_T2ADC(:,:,:);
param_maps_all(2,1:1:size(parameter_map_pe_uw_T2ADC,1), 1:size(parameter_map_pe_uw_T2ADC,2), 1:
% Load IVIM
param_maps_all(3,1:size(parameter_map_h_uw_IVIM,1),:,:) = parameter_map_h_uw_IVIM(:,:,:);
param_maps_all(4,1:1:size(parameter_map_pe_uw_IVIM,1), 1:size(parameter_map_pe_uw_IVIM,2), 1:si
% Load 3 Compartment
param_maps_all(5,:,:,:) = parameter_map_h_uw_3_comp(:,:,:);
param_maps_all(6,:, 1:size(parameter_map_pe_uw_3_comp,2), 1:size(parameter_map_pe_uw_3_comp,3))
```

Move D maps to log space

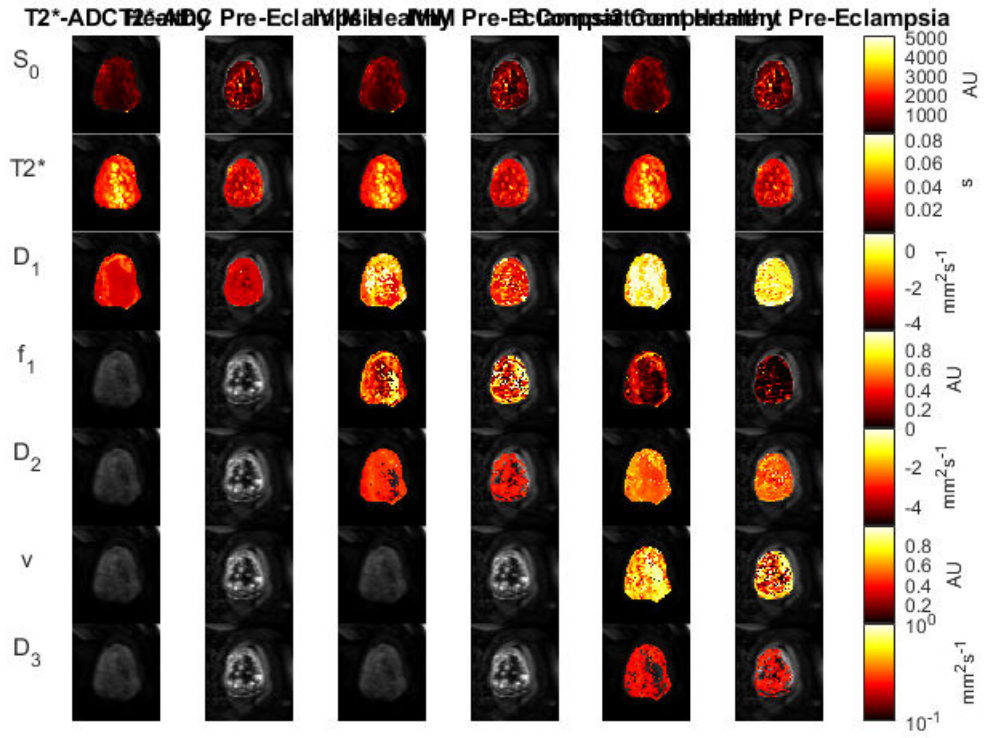
```
param_maps_all(:,3, :, :) = log10(param_maps_all(:,3, :, :));
param_maps_all(:,5, :, :) = log10(param_maps_all(:,5, :, :));
param_maps_all(:,7, :, :) = log10(param_maps_all(:,7, :, :));
param_maps_all(param_maps_all<-5) = 0;
```

Plot variables

```
param_labels = ["S_0", "T2*", "D_1", "f_1", "D_2", "v", "D_3"];
map_labels = ["T2*-ADC Healthy", "T2*-ADC Pre-Eclampsia", "IVIM Healthy", "IVIM Pre-Eclampsia",
param_units = ["AU", "s", "mm^2s^{-1}", "AU", "mm^2s^{-1}", "AU", "mm^2s^{-1}"];
```

Plot maps

```
figure();
tiledlayout(size(param_maps_all,2),6, 'TileSpacing', 'none');
Plotter.visualise_param_maps(param_maps_all, squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_pre
set(gca,'ColorScale','log')
```



Task 6- BIC

```
num_models = 3;
num_maps = 4;
num_scans = size(grad_echo,1);
```

Collect all SSE maps together

```
SSE_maps = zeros([num_maps, num_models, size(best_SSD_map_h_uw_T2ADC)]);
SSE_maps(1, 1,:,:) = best_SSD_map_h_T2ADC;
SSE_maps(2, 1, 1:size(best_SSD_map_pe_T2ADC,1), 1:size(best_SSD_map_pe_T2ADC,2)) = best_SSD_map
SSE_maps(3, 1,:,:) = best_SSD_map_h_uw_T2ADC;
SSE_maps(4, 1, 1:size(best_SSD_map_pe_uw_T2ADC,1), 1:size(best_SSD_map_pe_uw_T2ADC,2)) = best_S

SSE_maps(1, 2,:,:) = best_SSD_map_h_IVIM;
SSE_maps(2, 2, 1:size(best_SSD_map_pe_IVIM,1), 1:size(best_SSD_map_pe_IVIM,2)) = best_SSD_map_p
SSE_maps(3, 2,:,:) = best_SSD_map_h_uw_IVIM;
SSE_maps(4, 2, 1:size(best_SSD_map_pe_uw_IVIM,1), 1:size(best_SSD_map_pe_uw_IVIM,2)) = best_SSD

SSE_maps(1, 3,:,:) = best_SSD_map_h_3_comp;
SSE_maps(2, 3, 1:size(best_SSD_map_pe_3_comp,1), 1:size(best_SSD_map_pe_3_comp,2)) = best_SSD_m
SSE_maps(3, 3,:,:) = best_SSD_map_h_uw_3_comp;
SSE_maps(4, 3, 1:size(best_SSD_map_pe_uw_3_comp,1), 1:size(best_SSD_map_pe_uw_3_comp,2)) = best
```

Collect all the BIC maps into 1 matrix

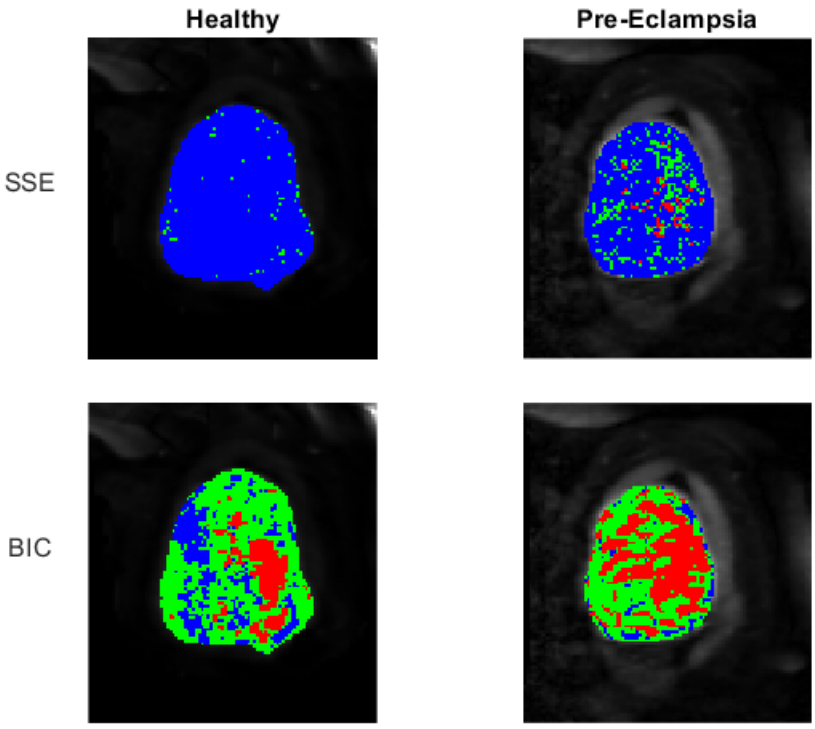
```
BIC_maps = zeros([num_maps, num_models, size(best_SSD_map_h_uw_T2ADC)]);
BIC_maps(1, 1,:,:) = BIC_gaussian(length(start_params_T2ADC), num_scans, best_SSD_map_h_T2ADC);
BIC_maps(2, 1, 1:size(best_SSD_map_pe_T2ADC,1), 1:size(best_SSD_map_pe_T2ADC,2)) = BIC_gaussian
BIC_maps(3, 1,:,:) = BIC_gaussian(length(start_params_T2ADC), num_scans, best_SSD_map_h_uw_T2AD
BIC_maps(4, 1, 1:size(best_SSD_map_pe_uw_T2ADC,1), 1:size(best_SSD_map_pe_uw_T2ADC,2)) = BIC_ga

BIC_maps(1, 2,:,:) = BIC_gaussian(length(start_params_IVIM), num_scans, best_SSD_map_h_IVIM);
BIC_maps(2, 2, 1:size(best_SSD_map_pe_IVIM,1), 1:size(best_SSD_map_pe_IVIM,2)) = BIC_gaussian(
BIC_maps(3, 2,:,:) = BIC_gaussian(length(start_params_IVIM), num_scans, best_SSD_map_h_uw_IVIM
BIC_maps(4, 2, 1:size(best_SSD_map_pe_uw_IVIM,1), 1:size(best_SSD_map_pe_uw_IVIM,2)) = BIC_gaus

BIC_maps(1, 3,:,:) = BIC_gaussian(length(start_params_3_Comp), num_scans, best_SSD_map_h_3_comp
BIC_maps(2, 3, 1:size(best_SSD_map_pe_3_comp,1), 1:size(best_SSD_map_pe_3_comp,2)) = BIC_gaussi
BIC_maps(3, 3,:,:) = BIC_gaussian(length(start_params_3_Comp), num_scans, best_SSD_map_h_uw_3_c
BIC_maps(4, 3, 1:size(best_SSD_map_pe_uw_3_comp,1), 1:size(best_SSD_map_pe_uw_3_comp,2)) = BIC_
```

Plot maps

```
map_labels = ["Healthy", "Pre-Eclampsia"];
figure();
tiledlayout(2,2, 'TileSpacing', 'Tight');
Plotter.compare_models(SSE_maps(3:4,:,:,:), squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_pre
Plotter.compare_models(BIC_maps(3:4,:,:,:), squeeze(V_healthy(:,:,slice_num,1)), squeeze(V_pre
```




```
sum(SSE_maps, [3,4])
```

```
ans = 4×3
10^7 ×
```

```
    1.7206    1.4473    1.4485
    0.6416    0.5888    0.5608
    4.8138    3.7996    3.7736
    1.1813    1.0338    1.0563
```

```
sum(BIC_maps, [3,4])
```

```
ans = 4×3
10^6 ×
    1.2544    1.2195    1.2301
    0.9269    0.9184    0.9270
    3.2804    3.1373    3.1491
    1.6188    1.5880    1.6096
```

Fitting helper funcs

```
function numRuns = num_runs_to_get_min_95_percent_time(sorted_SSD)
    % Calculated as P(minumum in run) = 1-P(minimum is not in run)
    %               0.95 = 1 - (1-occurance_min)^n
    % Tolerance required as == large floating point numbers (hence high
    % tolerance)
    tol = 10^-01;
    occurance_min = sum(abs(sorted_SSD-sorted_SSD(1)) < tol)/length(sorted_SSD)
    numRuns = log(0.05)/log(1-occurance_min);
end
```

Plotting funcs

```
function visualise_model_voxel_fit(predicted, actual, plot_title)
    plot(actual, ' bs')%, 'MarkerSize', 10, 'Linewidth', 4);
    hold on;
    plot(predicted, ' rx')%, 'MarkerSize', 16, 'Linewidth', 4);
    title(plot_title);
    xlabel('sample index');
    ylabel('S');
    hold off;
end

function plotMaps(parameter_map, SSD_map)
    % Plots parameters as a series of subplots
    S0 = parameter_map(1,:,:);
    T_star = parameter_map(2,:,:);
    d = parameter_map(3,:,:);

    plot_parameter(S0, 1, 'S_0');
    plot_parameter(T_star, 2, 'T2^*');
    plot_parameter(d, 3, 'D');
    plot_parameter(SSD_map, 4, 'SSD');
end

function plot_parameter(parameter, subplot_num, subplot_title)
    subplot(2,2,subplot_num);
    % Set upper bound as 10th highest value to handle outliers
    sorted_param = sort(parameter(:));
    imshow(flipud(squeeze(parameter)'), [0 sorted_param(end-25)]);
```

```
    title(subplot_title);
end

function BIC = BIC_gaussian(N, K, SSE)
    BIC = zeros(size(SSE));
    BIC = (N+1)*log(K) + K*log(SSE/K);
    BIC(BIC==-Inf) = 0;
end
```