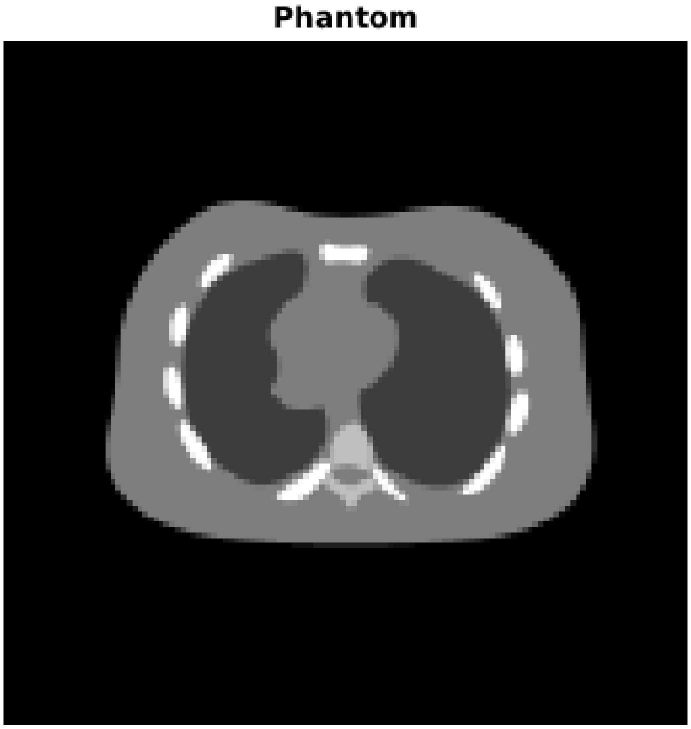
Report Q2

Table of Contents

Init

```
tic
rng(0);
phantom = imread("../data/ChestPhantom.png");
phantom = mat2gray(phantom);
theta = linspace(0,179,180);
[R,xp] = radon(phantom,theta);
imshow(phantom);
title("Phantom");
```



Phantom

Part a

```
A = system_mat(128, theta);
A = sparse(A);
```

We have used the standard basis for $R^{128*128}$.

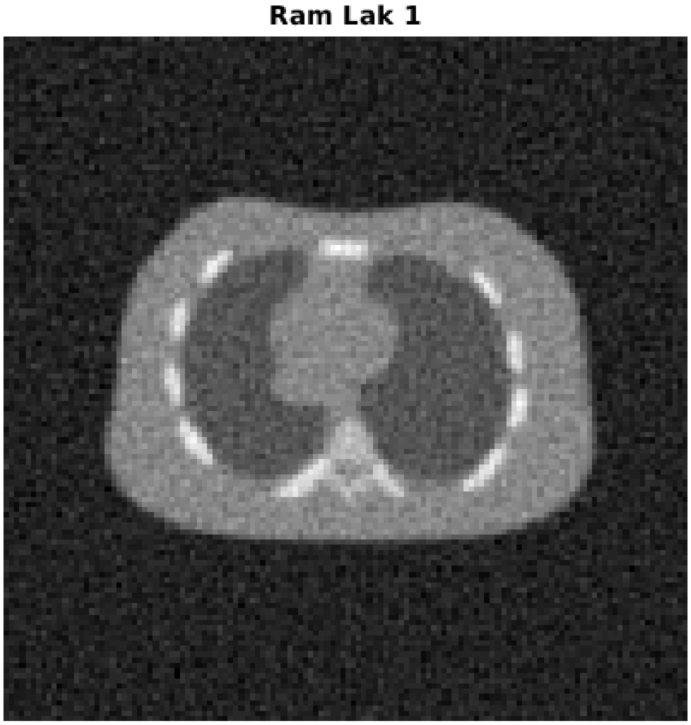
Part b

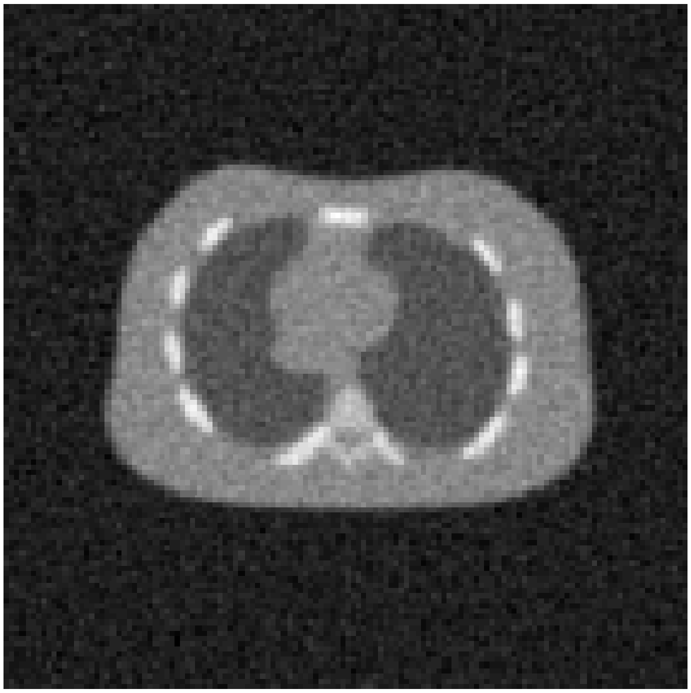
```
b = A*reshape(phantom,[],1);
noisy_b = b + 0.02*range(b)*randn(length(b),1);
```

Part c

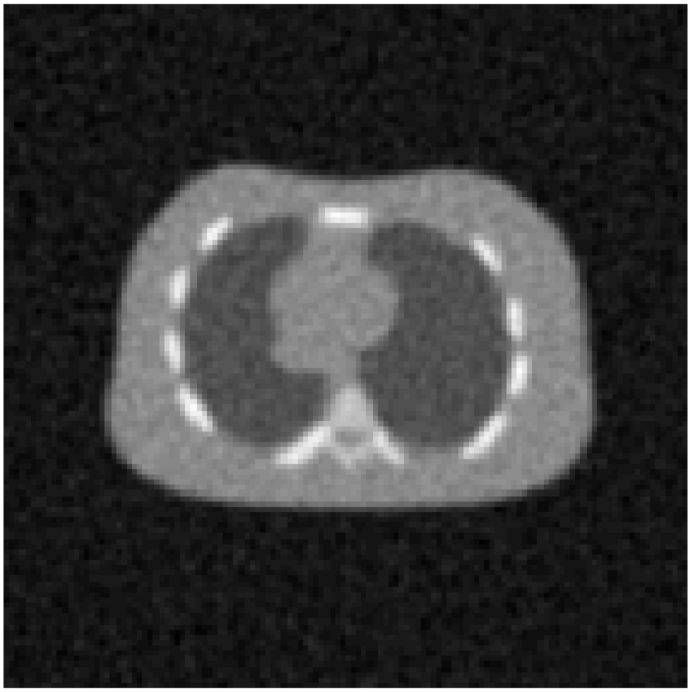
```
[Ram_Lak_filtered,Shepp_Logan_filtered,Cosine_filtered] =
 myFilter(reshape(noisy_b,185,180),xp,theta,1);

I1 = mat2gray(iradon(Ram_Lak_filtered,theta,'linear','none',128));
I2 = mat2gray(iradon(Shepp_Logan_filtered,theta,'linear','none',128));
I3 = mat2gray(iradon(Cosine_filtered,theta,'linear','none',128));
```

```
Rc = zeros(1,3);
Rc(1) = RRMSE(phantom,I1);
Rc(2) = RRMSE(phantom,I2);
Rc(3) = RRMSE(phantom,I3);

figure()
imshow(I1);
title("Ram Lak 1");

figure()
imshow(I2);
title("Shepp Logan 1");

figure()
imshow(I3);
title("Cosine 1");

figure()
imshow(phantom);
title("Original");
```

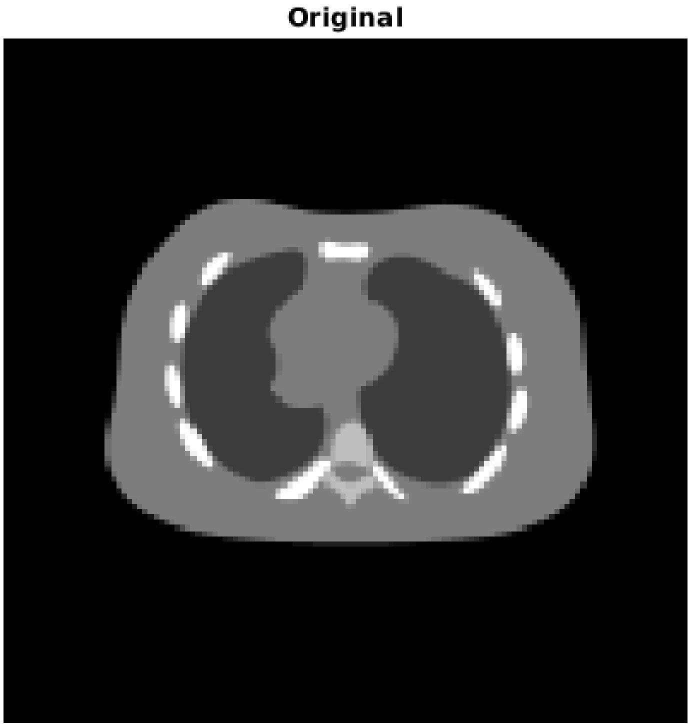




Shepp Logan 1



Cosine 1



RRMSE Values

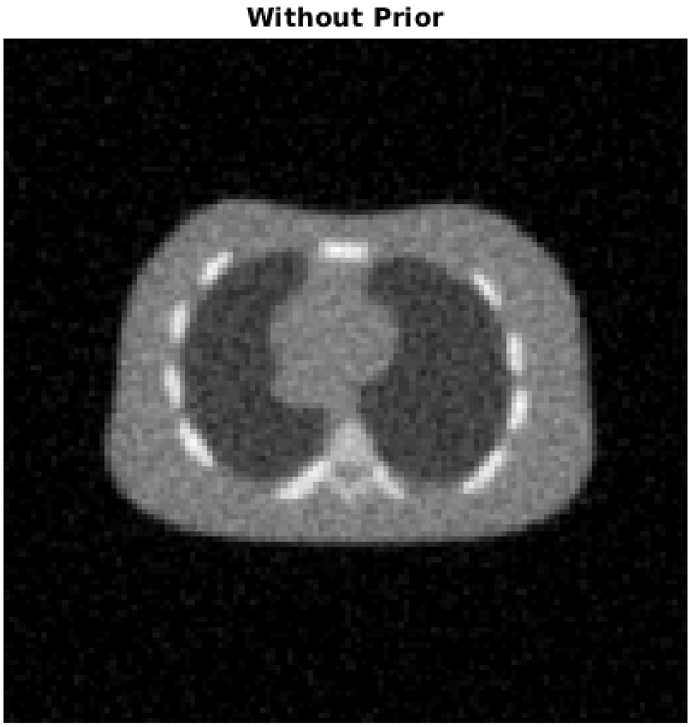
```
disp("RRMSE Values:")
disp("Ram-Lak: "+ Rc(1))
disp("Shepp-Logan: "+ Rc(2))
disp("Cosine: "+ Rc(3))
```

```
RRMSE Values:
Ram-Lak: 0.48699
Shepp-Logan: 0.43802
Cosine: 0.33888
```

Part d

```
t_opt = 12;

x = tikhonov(A,noisy_b,t_opt);

img = mat2gray(reshape(x,[],128));
figure()
imshow(img)
title("Without Prior")

phantom = reshape(phantom,[],1);
Rd = RRMSE(phantom,x);
```

```
Rdm = 0.15533;
Rdp = 0.15533;

%Uncomment the following part to Cross-Check if you want. The may take
% upto 1 min extra to run after uncommenting
%xm = tikhonov(A,noisy_b,0.8*t_opt);
%xp = tikhonov(A,noisy_b,1.2*t_opt);
%Rem(1) = RRMSE(phantom,xm);
%Rep(1) = RRMSE(phantom,xp);
```



Tikhonov Regularzation Values

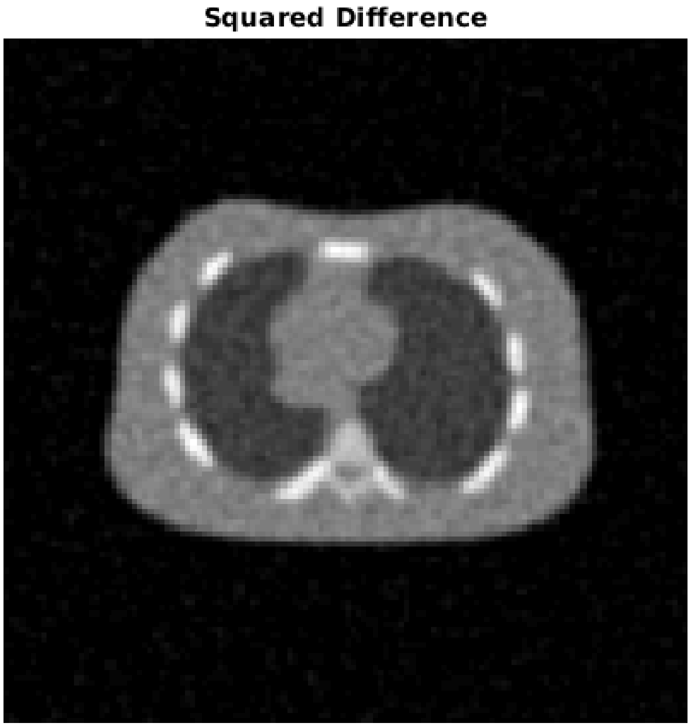
```
disp("Optimum Parameter Value: " +t_opt)
disp("RRMSE at optimum Value: " + Rd)
disp("RRMSE at 1.2*opt_value: " + Rdm)
disp("RRMSE at 0.8*opt_value: " + Rdp)
```

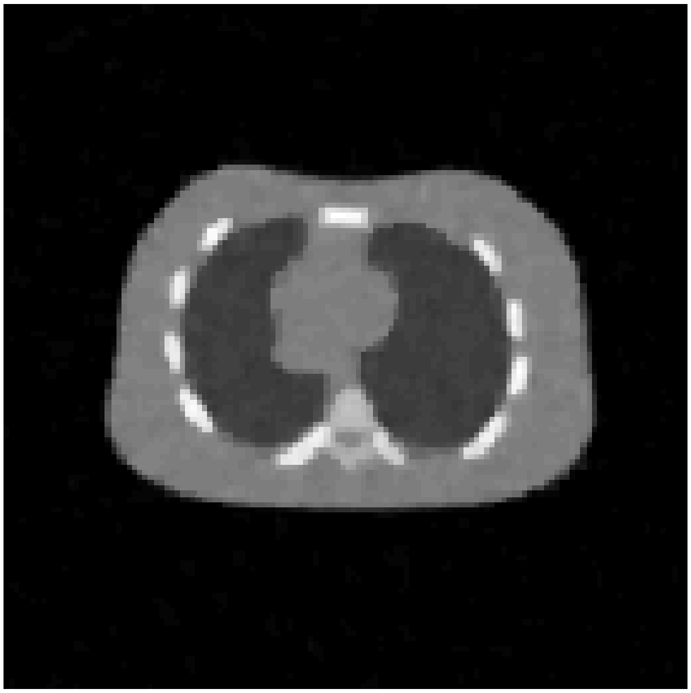
```
Optimum Parameter Value: 12
RRMSE at optimum Value: 0.14619
RRMSE at 1.2*opt_value: 0.15533
RRMSE at 0.8*opt_value: 0.15533
```

Part e

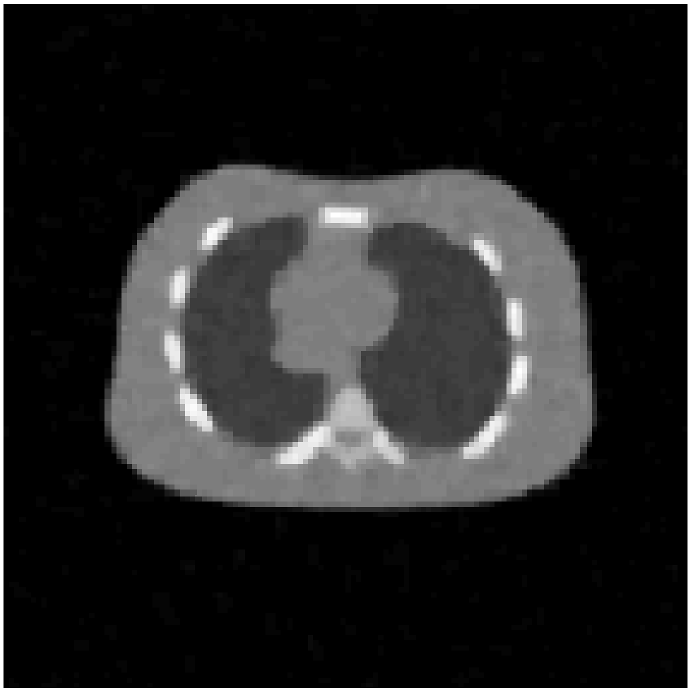
```
a_opt = [80 420 700];
```

```
g_opt = [1 0.02 0.015];
Re = zeros(1,3);
Rem_a = zeros(1,3);
Rem_g = zeros(1,3);
Rep_a = zeros(1,3);
Rep_g = zeros(1,3);

x1 =
 gradient_descent1(A,noisy_b,a_opt(1),g_opt(1),0.01,1e-8,100,1,zeros(128*128,1));
img1 = reshape(x1,[],128);
figure()
imshow(img1);
title("Squared Difference");

x2 =
 gradient_descent1(A,noisy_b,a_opt(2),g_opt(2),0.01,1e-8,100,2,zeros(128*128,1));
img2 = reshape(x2,[],128);
figure()
imshow(img2);
title("Huber");

x3 =
 gradient_descent1(A,noisy_b,a_opt(3),g_opt(3),0.01,1e-8,100,3,zeros(128*128,1));
figure()
img3 = reshape(x3,[],128);
imshow(img3);
title("Discontinuity Adaptive");

Re(1) = RRMSE(phantom,x1);
Re(2) = RRMSE(phantom,x2);
Re(3) = RRMSE(phantom,x3);

%reporting values for 0.8* and 1.2* opt parameters
Rem_a(1) = 0.12299;
Rem_a(2) = 0.0867;
Rem_a(3) = 0.0901;

Rem_g(4) = 0.12299;
Rem_g(2) = 0.0860;
Rem_g(3) = 0.0883;

Rep_a(1) = 0.12299;
Rep_a(2) = 0.0863;
Rep_a(3) = 0.0885;

Rep_g(1) = 0.12299;
Rep_g(2) = 0.0864;
Rep_g(3) = 0.0895;

%huber function
% a | g | rrmse
% 420 | 0.02 | 0.0846 <----------
% 420 | 0.016 | 0.0860
% 420 | 0.024 | 0.0864
% 504 | 0.02 | 0.0863
% 336 | 0.02 | 0.0867

%discontinuity
% a | g | rrmse
% 700 | 0.015 | 0.0884 <---------
% 700 | 0.018 | 0.0895
% 700 | 0.012 | 0.0883
% 560 | 0.015 | 0.0901
% 840 | 0.015 | 0.0885
```





Huber



Discontinuity Adaptive

Squarred Error Values

```
disp("Optimum Parameter Value Sq. Error: a = " + a_opt(1) + ", g = " +
 g_opt(1));
disp("RRMSE at optimum Values: " + Re(1))
disp("RRMSE at 1.2*a: " + Rem_a(1))
disp("RRMSE at 0.8*a: " + Rep_a(1))
disp("Parameter g : NA")
```

```
Optimum Parameter Value Sq. Error: a = 80, g = 1
RRMSE at optimum Values: 0.12221
RRMSE at 1.2*a: 0.12299
RRMSE at 0.8*a: 0.12299
Parameter g : NA
```

Huber Function Values

```
disp("Optimum Parameter Value Huber: a = " + a_opt(2) + ", g = " +
 g_opt(2));
disp("RRMSE at optimum Value: " + Re(2))
disp("RRMSE at 1.2*a: " + Rep_a(2))
disp("RRMSE at 0.8*a: " + Rem_a(2))
disp("RRMSE at 1.2*g: " + Rep_g(2))
disp("RRMSE at 0.8*g: " + Rem_g(2))
```

```
Optimum Parameter Value Huber: a = 420, g = 0.02
RRMSE at optimum Value: 0.084596
RRMSE at 1.2*a: 0.0863
RRMSE at 0.8*a: 0.0867
RRMSE at 1.2*g: 0.0864
RRMSE at 0.8*g: 0.086
```

Discontinuity Adaptive Prior Function Values

```
disp("Optimum Parameter Values Disc. adaptive: a = " + a_opt(3) + ", g
 = " + g_opt(3));
disp("RRMSE at optimum Value: " + Re(3))
disp("RRMSE at 1.2*a: " + Rep_a(3))
disp("RRMSE at 0.8*a: " + Rem_a(3))
disp("RRMSE at 1.2*g: " + Rep_g(3))
disp("RRMSE at 0.8*g: " + Rem_g(3))
toc
```

```
Optimum Parameter Values Disc. adaptive: a = 700, g = 0.015
RRMSE at optimum Value: 0.088435
RRMSE at 1.2*a: 0.0885
RRMSE at 0.8*a: 0.0901
RRMSE at 1.2*g: 0.0895
RRMSE at 0.8*g: 0.0883
Elapsed time is 115.320712 seconds.
```

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