Extra Credit

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Qiaomin Wang
Math 3607 Spring 2019

Introduction

```
function Extra()
% Call your homework problems like this :
    hmwk_problem(@prob1,'prob1');
    hmwk_problem(@prob2,'prob2');
end

%%%%%%%%%%%%%%%%%%% Homework utility routines %%%%%%%%%%%%%%%%%%%%%%%
function hmwk_problem(prob,msg)
    try
        prob()
        fprintf('%s : Ran to completion.\n',msg);
    catch me
        fprintf('%s : Something went wrong.\n',msg);
        fprintf('%s\n',me.message);
    end
    fprintf('\n');
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

#1 (13.1-32)

```
function prob1()
% Your solution goes here
%a)
disp('a)')
figure(1)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'r.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX','MarkerSize', 20)
plot(z_zeroes(2),'gX','MarkerSize', 20)
plot(z_zeroes(3),'bX','MarkerSize', 20)
[x, y] = ginput(1);
plot(x,y);
colors = 'rgbmc';
```

```
nr_iter = 0;
z = x+1i*y;
while true
    nr_iter = nr_iter + 1;
    Znew = (1/3)*(2*z-1/z^2);
    z = Znew;
    ic = mod(nr_iter, 5) + 1;
    plot(z, '.', 'Color', colors(ic));
    if min(abs(z - z_zeroes)) < 1e-8
        break
    end
    disp(Znew)
end
%b)&&c)
figure(2)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX','MarkerSize', 20)
plot(z_zeroes(2),'gX','MarkerSize', 20)
plot(z_zeroes(3),'bX','MarkerSize', 20)
[x, y] = ginput(2);
nr_x = length(x);
nr_y = length(y);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
Z = Z0;
colors = 'rgb';
while true
    Znew = (1/3)*(2*Z-1./Z.^2);
    Z = Znew;
    i_conv1 = find(abs(Z - z_zeroes(1)) < 1e-8);
    i_conv2 = find(abs(Z - z_zeroes(2)) < 1e-8);
    i_conv3 = find(abs(Z - z_zeroes(3)) < 1e-8);
    if length(i_conv1)+length(i_conv2)+length(i_conv3) == nr_x*nr_y
        plot(Z0(i_conv1),'o','Color', colors(1))
        plot(Z0(i_conv2),'o','Color', colors(2))
        plot(Z0(i_conv2),'o','Color', colors(3))
        break
    end
end
%d)
figure(3)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX','MarkerSize', 20)
plot(z_zeroes(2),'bX','MarkerSize', 20)
```

```
plot(z_zeroes(3),'gX','MarkerSize', 20)
x = linspace(-2,2,1000);
y = linspace(-2,2,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
    end
end
%e)
%i)
figure(4)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([0.1 1.1 0 1])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
x = linspace(0.1,1.1,1000);
y = linspace(0,1,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
```

```
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
    end
end
%ii)
disp('e)ii)')
figure(5)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'r.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'gX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'cX')
[x, y] = ginput(1);
plot(x,y);
colors = 'rgbmc';
nr_iter = 0;
z = x+1i*y;
while true
    nr_iter = nr_iter + 1;
    Znew = (1/3)*(2*z-1/z^2);
    z = Znew;
```

```
    ic = mod(nr_iter, 5) + 1;
    plot(z, '.', 'Color', colors(ic));
    if min(abs(z - z_zeroes)) < 1e-8
        break
    end
    disp(Znew)
end
disp('e)ii) Becuase when we plug z0 = 0.5 into Newtons method, we can
 find that z1 = -1 which is a zero. It means the intensity is really
 small.')
%iii)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%L = 1e-1%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(6)
L = 1e-1;
xmin = 2^(-1/3) - L/2;
xmax = 2^(-1/3) + L/2;
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([xmin xmax 0 L])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
x = linspace(xmin,xmax,1000);
y = linspace(0,L,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)
```

```
        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
    end
end
title('L = 1e-1')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%L = 1e-2%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(7)
L = 1e-2;
xmin = 2^(-1/3) - L/2;
xmax = 2^(-1/3) + L/2;
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([xmin xmax 0 L])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
x = linspace(xmin,xmax,1000);
y = linspace(0,L,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
```

```
        end
    end
    if length(z0) == 0
        break
    end
end
title('L = 1e-2')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%L = 1e-1=3%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(8)
L = 1e-3;
xmin = 2^(-1/3) - L/2;
xmax = 2^(-1/3) + L/2;
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([xmin xmax 0 L])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
x = linspace(xmin,xmax,1000);
y = linspace(0,L,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
```

```
    if length(z0) == 0
        break
    end
end
title('L = 1e-3')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%L = 1e-4%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(9)
L = 1e-4;
xmin = 2^(-1/3) - L/2;
xmax = 2^(-1/3) + L/2;
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([xmin xmax 0 L])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
x = linspace(xmin,xmax,1000);
y = linspace(0,L,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
```

```
    end
end
title('L = 1e-4')
%iv)
figure(10)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = exp(1i*pi*[1:2:5]/3);
plot(z_zeroes(1),'rX','MarkerSize', 20)
plot(z_zeroes(2),'bX','MarkerSize', 20)
plot(z_zeroes(3),'gX','MarkerSize', 20)
x = linspace(-2,2,1000);
y = linspace(-2,2,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    i_conv1 = find(abs(z - 2^(-1/3)) < 1e-2);
    plot(z(i_conv1),'o')
    znew = (1/3)*(2*z-1./z.^2);
    z = znew;
    for i = 1:nr_zeros
        i_conv2 = find(abs(z - z_zeroes(i)) < 1e-8);
        z(i_conv2) = [];
        z0(i_conv2) = [];
    end
    if isempty(z0)
        break
    end
end
%f)
figure(11)
f(1,2,3,4)
end
function f(a,b,c,d)
p = [a b c d];
z_zeroes = roots(p);
plot(z_zeroes(1),'rX')
axis equal
hold on
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
axis([min(real(z_zeroes))-1 max(real(z_zeroes))+1
 min(imag(z_zeroes))-1 max(imag(z_zeroes))+1])
x = linspace(min(real(z_zeroes))-1,max(real(z_zeroes))+1,1000);
y = linspace(min(imag(z_zeroes))-1,max(imag(z_zeroes))+1,1000);
```

```
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
while true
    n = n+1;
    znew = z-polyval(p,z)./polyval(polyder(p),z);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        else
            which_color = [s 1 s]; % green
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)
        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
    end
end
end
```

a)

22.5491 +61.8636i

15.0328 +41.2425i

10.0220 +27.4951i

6.6816 +18.3303i

4.4551 +12.2208i

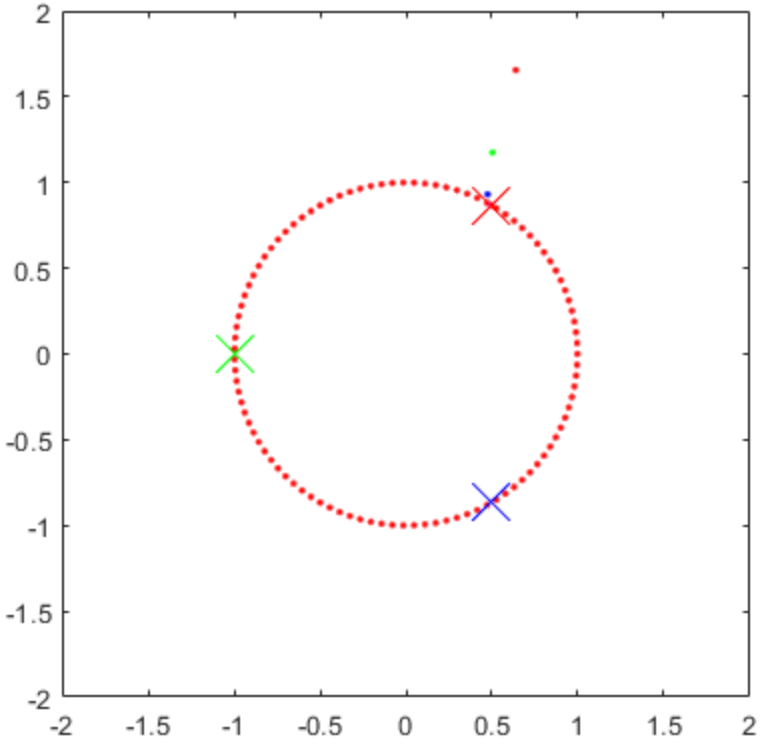
2.9716 + 8.1484i

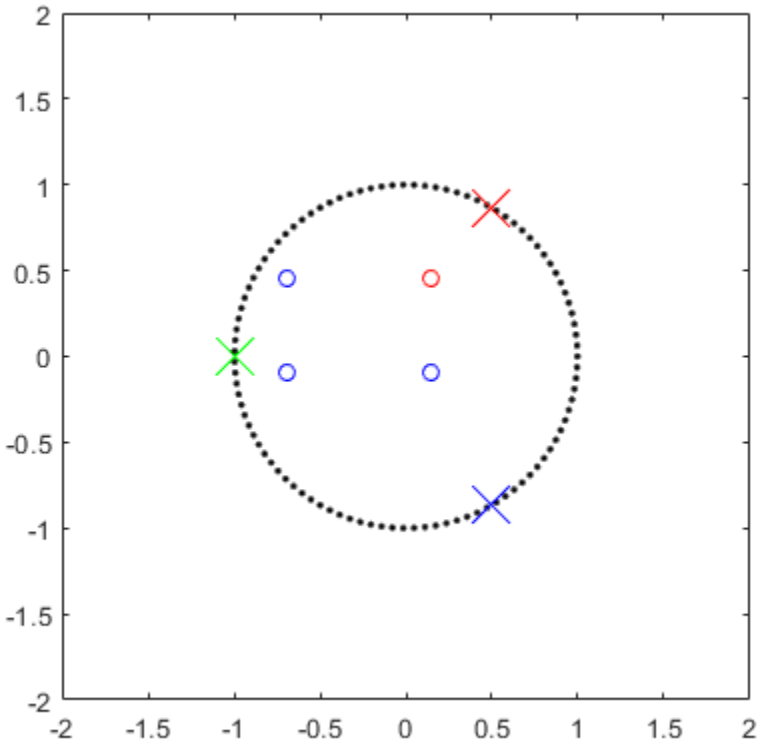
1.9844 + 5.4352i

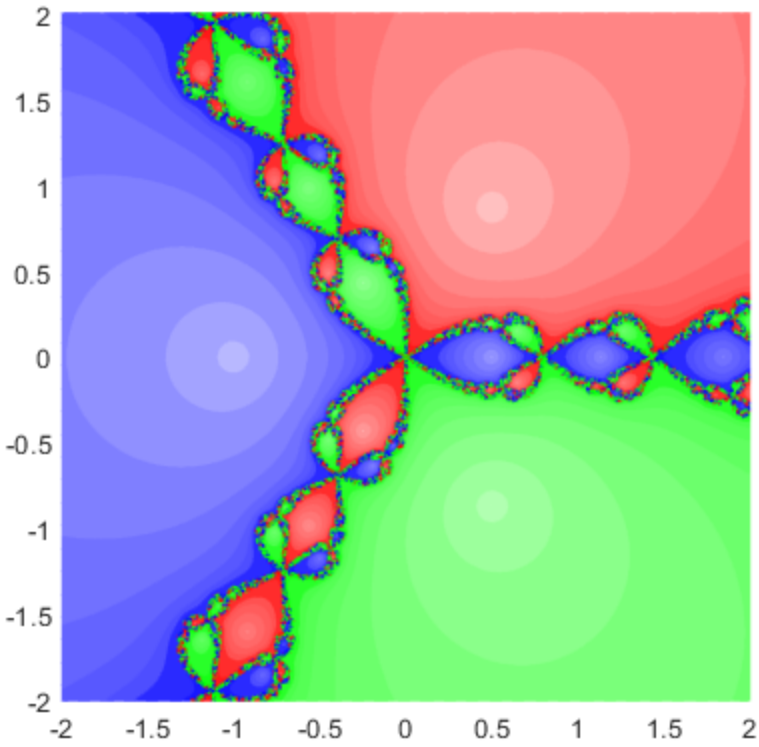
1.3306 + 3.6299i

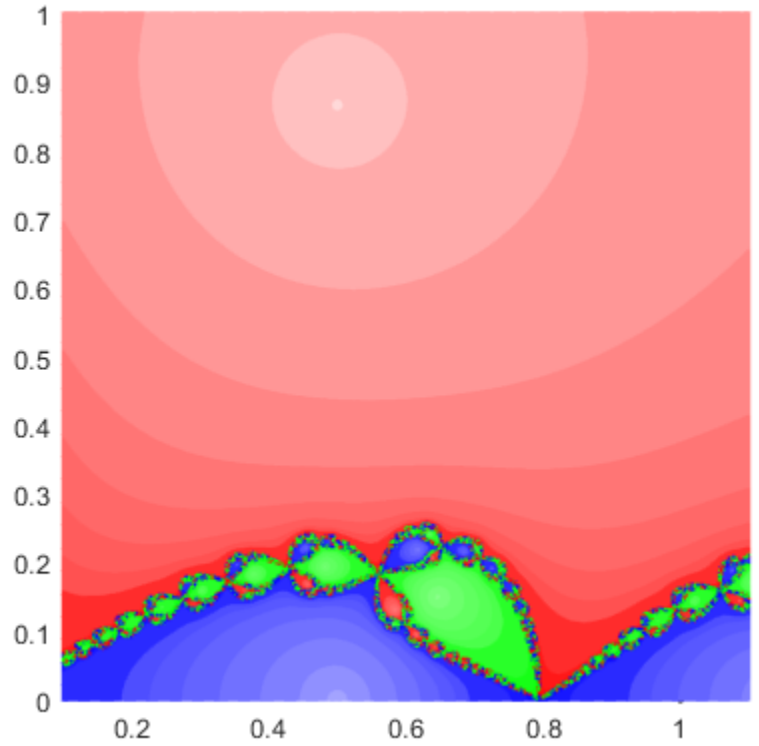
0.9041 + 2.4343i

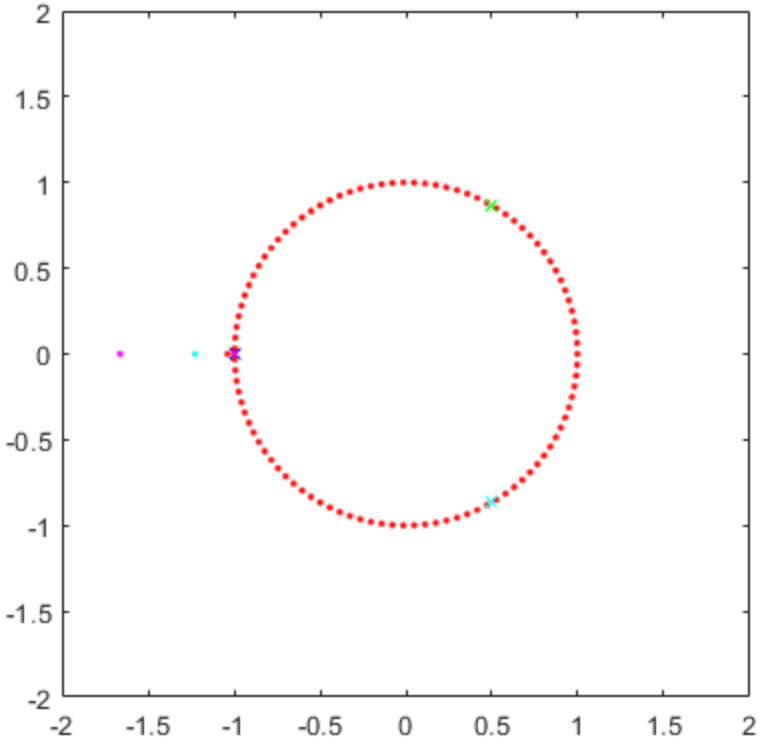
```
   0.6402 + 1.6551i

   0.5051 + 1.1746i

   0.4770 + 0.9311i

   0.4959 + 0.8679i

   0.5000 + 0.8660i

e)ii)
 -27.0843 + 0.0000i

 -18.0566 + 0.0000i

 -12.0388 + 0.0000i

  -8.0282 + 0.0000i

  -5.3573 + 0.0000i

  -3.5831 + 0.0000i

  -2.4147 + 0.0000i

  -1.6670 + 0.0000i

  -1.2313 + 0.0000i

  -1.0407 + 0.0000i

  -1.0016 + 0.0000i

  -1.0000 + 0.0000i

e)ii) Becuase when we plug z0 = 0.5 into Newtons method, we can find
 that z1 = -1 which is a zero. It means the intensity is really small.
prob1 : Ran to completion.
```

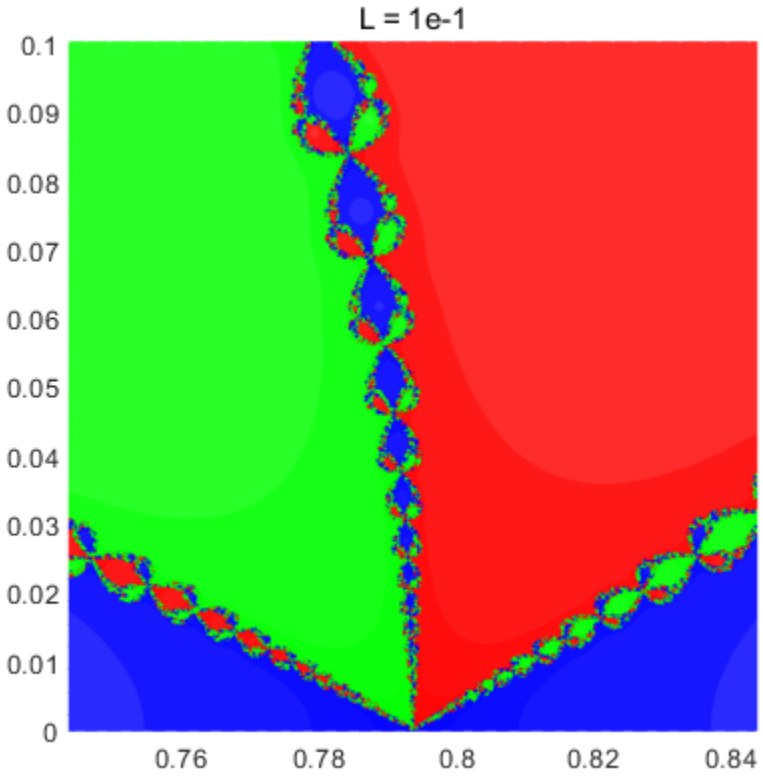

2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

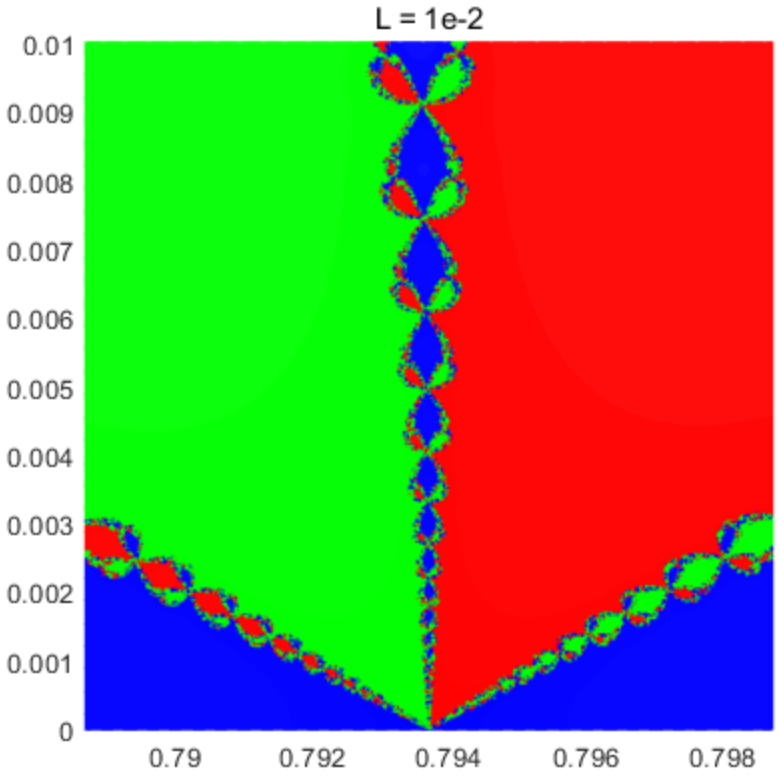

2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

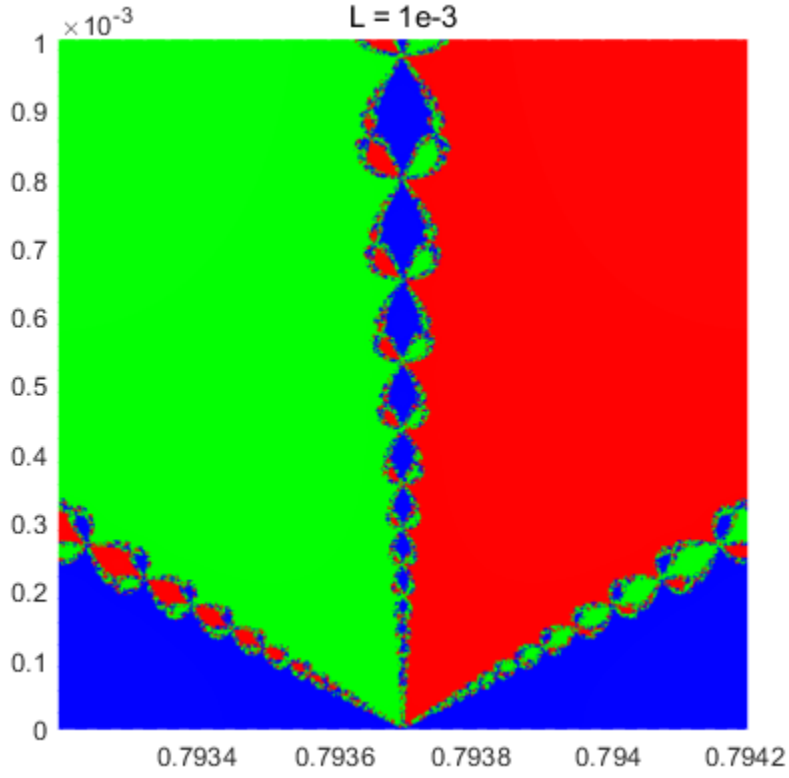

2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

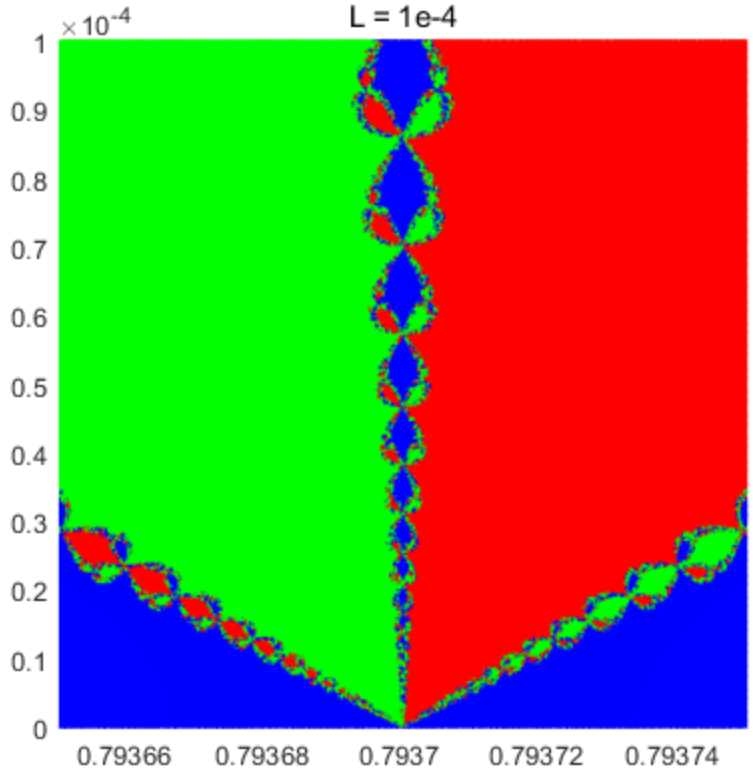

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.2
0.4
0.6
0.8
1

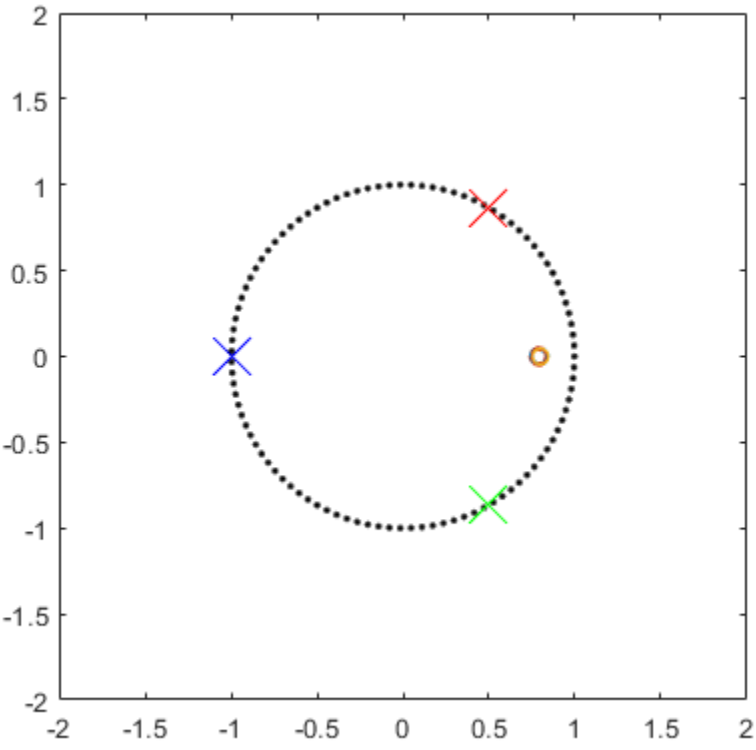

2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

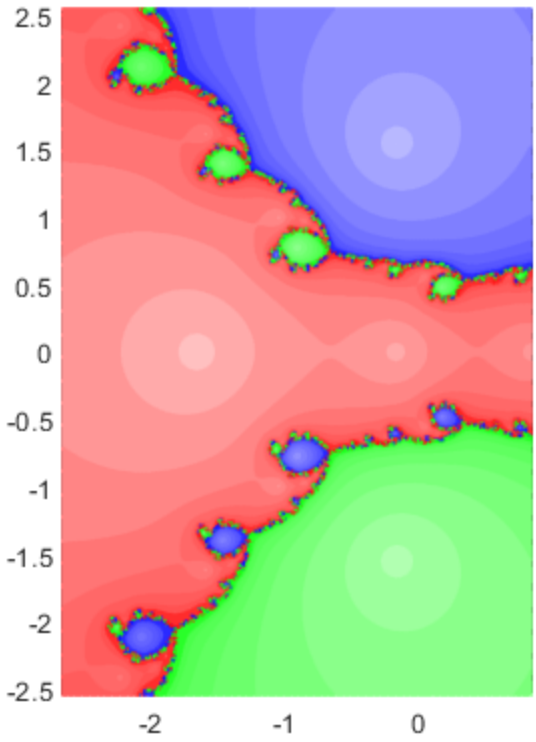

L = 1e-1
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.76
0.78
0.8
0.82
0.84


L = 1e-2
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0.79
0.792
0.794
0.796
0.798


L = 1e-3
×10^-3
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.7934
0.7936
0.7938
0.794
0.7942


L = 1e-4
×10^-4
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.79366
0.79368
0.7937
0.79372
0.79374


2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

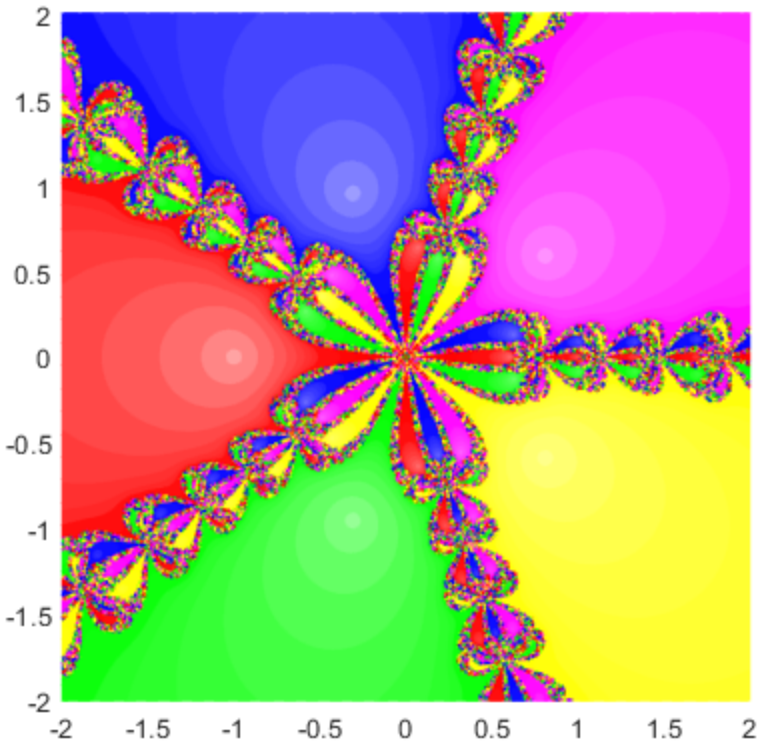


#2 (13.1-33)

```
function prob2()
% Your solution goes here
figure(12)
th = linspace(0,2*pi,100);
plot(cos(th),sin(th),'k.')
axis equal
axis([-2 2 -2 2])
hold on
z_zeroes = roots([1 0 0 0 0 1]);
plot(z_zeroes(1),'rX')
plot(z_zeroes(2),'bX')
plot(z_zeroes(3),'gX')
plot(z_zeroes(4),'mX')
plot(z_zeroes(5),'yX')
x = linspace(-2,2,1000);
y = linspace(-2,2,1000);
[X,Y] = meshgrid(x,y);
Z0 = X+1i*Y;
z0 = Z0(:);
z = z0;
nr_zeros = length(z_zeroes);
s = 1;
n = 0;
```

```
while true
    n = n+1;
    znew = (1/5)*(4*z-1./z.^4);
    z = znew;
    for i = 1:nr_zeros
        s = s*0.96;
        if n<10|| mod(n,5) == 0
        i_conv = find(abs(z - z_zeroes(i)) < 1e-8);
        if i == 2
            which_color = [s s 1]; % blue
        elseif i == 1
            which_color = [1 s s]; % red
        elseif i == 3
            which_color = [s 1 s]; % green
        elseif i == 4
            which_color = [1 s 1]; % magenta
        else
            which_color = [1 1 s]; % yellow
        end

        plot(real(z0(i_conv)), imag(z0(i_conv)), '.', 'Color',
 which_color, ...
        'MarkerSize', 1)

        z(i_conv) = [];
        z0(i_conv) = [];
        end
    end
    if length(z0) == 0
        break
    end
end
end
```

prob2 : Ran to completion.



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