

# Homework 4

## Problem 1

### Code (Number of Workers = 8)

```
if isempty(gcp())
    parpool();
end

nworkers = gcp().NumWorkers;

f = @(x,y) x.^2.*y.^2;
x = linspace(1,2,nworkers+1);

spmd
    ainit = x(labindex());
    bfin = x(labindex()+1);
    locint = integral2(f,ainit,bfin,-1,1);
    totalint = gplus(locint);
end

totalvalue = totalint{1};
disp(totalvalue); % Result: 1.5556
```

## Problem 2

### Code (Number of Workers = 8)

```
if isempty(gcp())
    parpool();
end

nworkers = gcp().NumWorkers;

f = @(x,y,z) x.^2.*y.^2.*z.^2;
x = linspace(1,2,nworkers+1);

spmd
    ainit = x(labindex());
    bfin = x(labindex()+1);
    locint = integral3(f,ainit,bfin,-1,1,2,3);
    totalint = gplus(locint);
end

totalvalue = totalint{1};
disp(totalvalue); % Result: 9.8519
```

## Problem 3

### Code (Number of Workers = 4) (1000x1000 Grid Domain) (Method 1)

```
clear;

% Starting 4 workers

if isempty(gcp())
    parpool(4);
end

maxIterations = 1000; gridSize = 1000;

xlim = [-0.748766713922161, -0.748766707771757];
ylim = [ 0.123640844894862, 0.123640851045266];

% Creating 1000x1000 grid domain

x = linspace(xlim(1),xlim(2),gridSize);
y = linspace(ylim(1),ylim(2),gridSize);

% Partitioning into 2x2 square blocks of 500x500 grid points each

lp1 = [0,0,0,0,500,500,500,500];
lp2 = [0,0,500,500,0,0,500,500];

% Each worker do a square block

tic();
spmd
    m = labindex()*2;
    n = m-1;
    [xGrid,yGrid] = meshgrid(x(1+lp1(n):500+lp1(m)),y(1+lp2(n):500+lp2(m)));
    z0 = xGrid + 1i*yGrid;

    count = ones(size(z0));
    z = z0;

    for n = 0:maxIterations
        z = z.*z + z0;
        inside = abs(z)<=2;
        count = count + inside;
    end
    count = log(count);
end
cpuTime = toc();

set(gcf, 'Position', [200 200 600 600] );

% Concatenate all square blocks to a single 1000x1000 grid

count1 = cat(2,count{1},count{3});
count2 = cat(2,count{2},count{4});
imagesc(x,y,cat(1,count1,count2));

% Display the image
```

```
axis image; axis off;
colormap([jet();flipud(jet());0 0 0]); drawnow;
title(sprintf('Elapsed time: %1.2fsecs ',cpuTime));
```

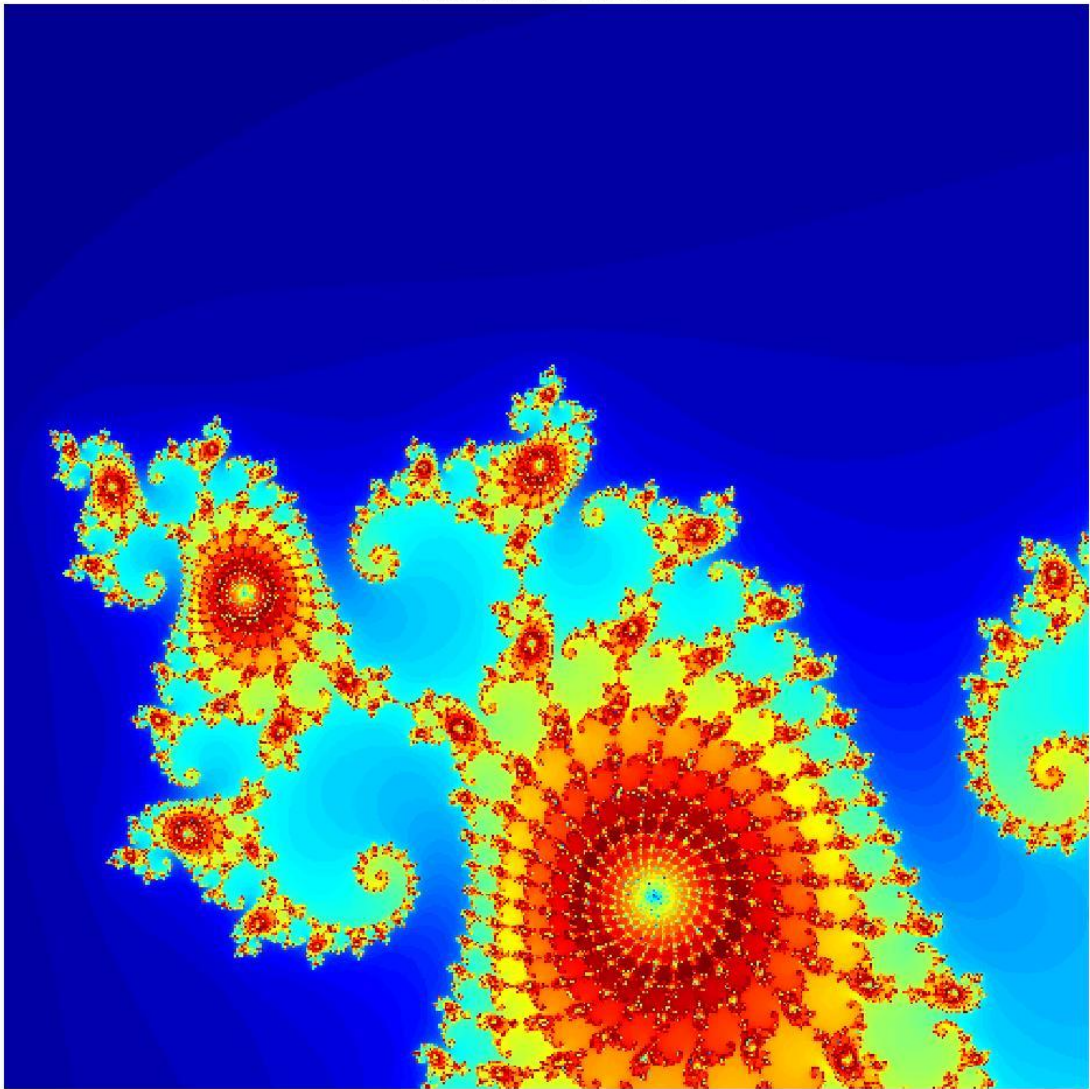
## Code (Number of Workers = 4) (1000x1000 Grid Domain) (Method 2)

```
clear; close all;
if isempty(gcf())
    parpool(4);
end
nworkers = gcp().NumWorkers;
maxIterations = 1000; gridSize = 1000;
xlim = [-0.748766713922161, -0.748766707771757];
ylim = [ 0.123640844894862, 0.123640851045266];
xlim = linspace(xlim(1),xlim(end),nworkers/2+1);
ylim = linspace(ylim(1),ylim(end),nworkers/2+1);
tic();
spmd
    l = labindex();
    if l==1; m=1; n=1; elseif l==2; m=1;n=2; elseif l==3; m=2;n=1; else; m=2;n=2; end
    x = linspace(xlim(m),xlim(m+1),gridSize/numlabs()*2);
    y = linspace(ylim(n),ylim(n+1),gridSize/numlabs()*2);
    [xGrid,yGrid] = meshgrid(x,y);
    z0 = xGrid + 1i*yGrid;
    count = ones(size(z0));
    z = z0;
    for n = 0:maxIterations
        z = z.*z + z0;
        inside = abs( z )<=2; count = count + inside;
    end
    count = log(count);
end
cpuTime = toc();
set( gcf,'Position',[200 200 600 600] );
count1 = cat(2,count{1},count{3});
count2 = cat(2,count{2},count{4});
imagesc(cat(1,count1,count2));
axis image; axis off; colormap([jet();flipud(jet());0 0 0]); drawnow;
title( sprintf('Elapsed Time: %1.2fsecs',cpuTime));
```

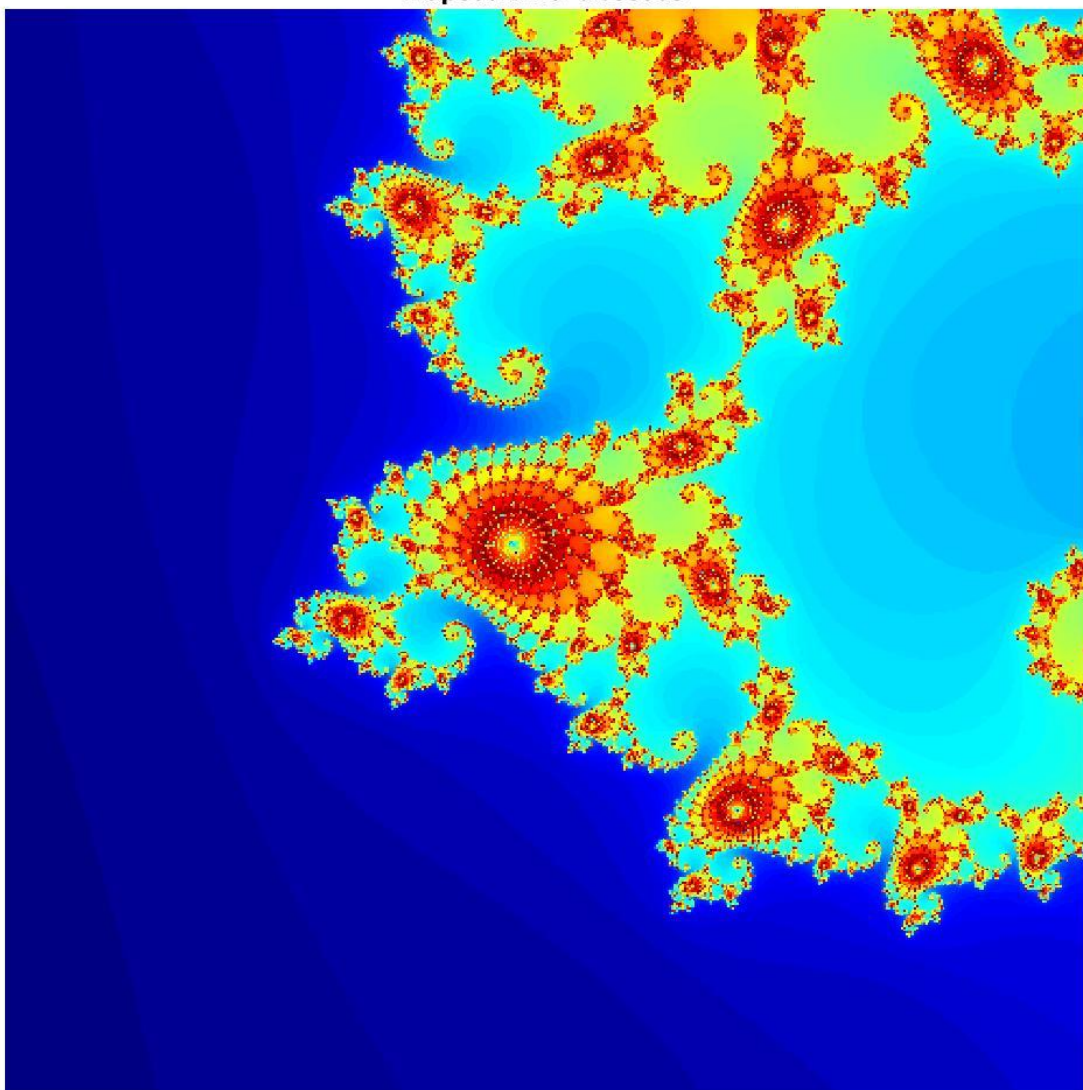
**Result**

**Separate Blocks**

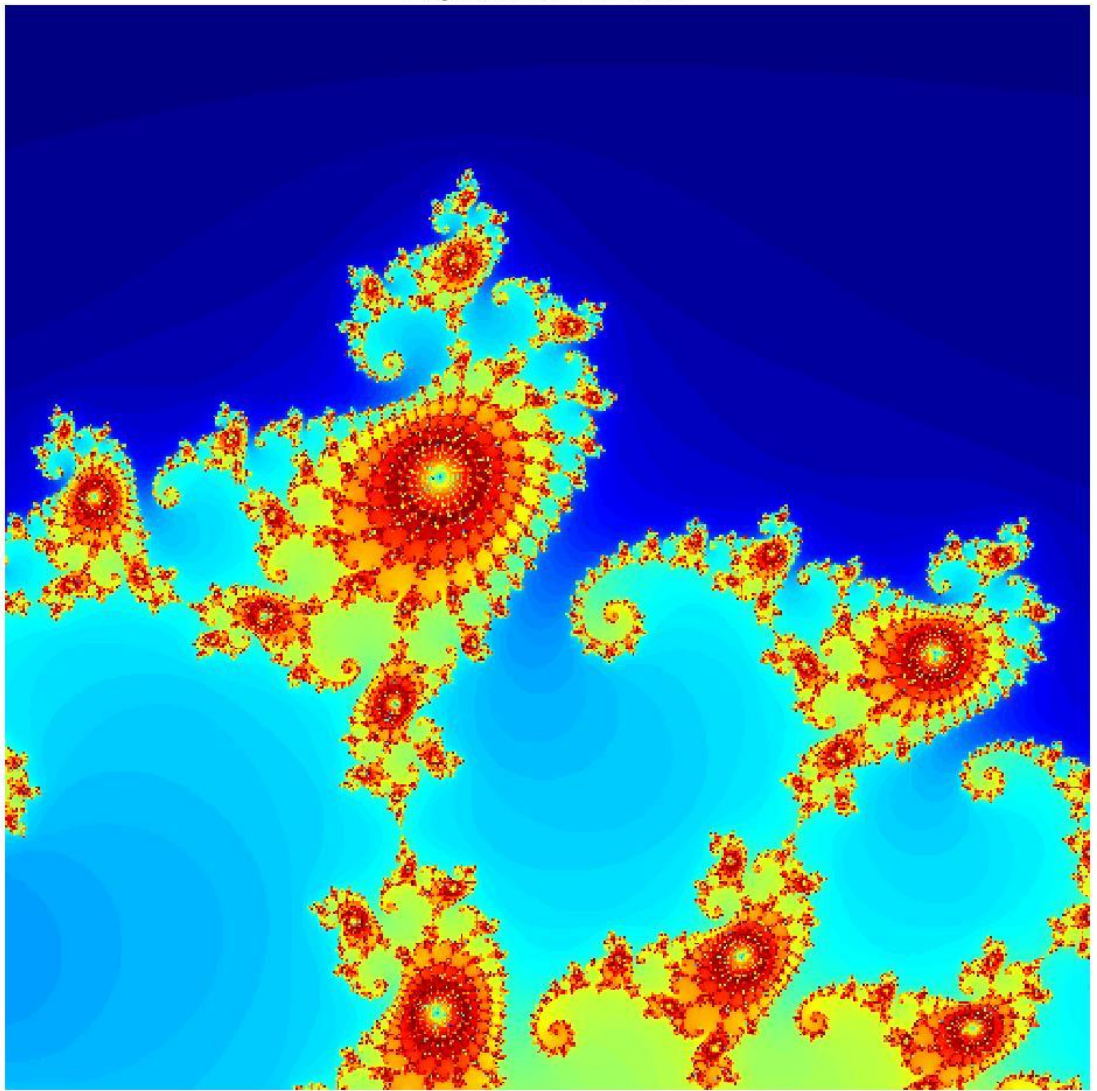
Elapsed time: 6.66secs



Elapsed time: 6.68secs

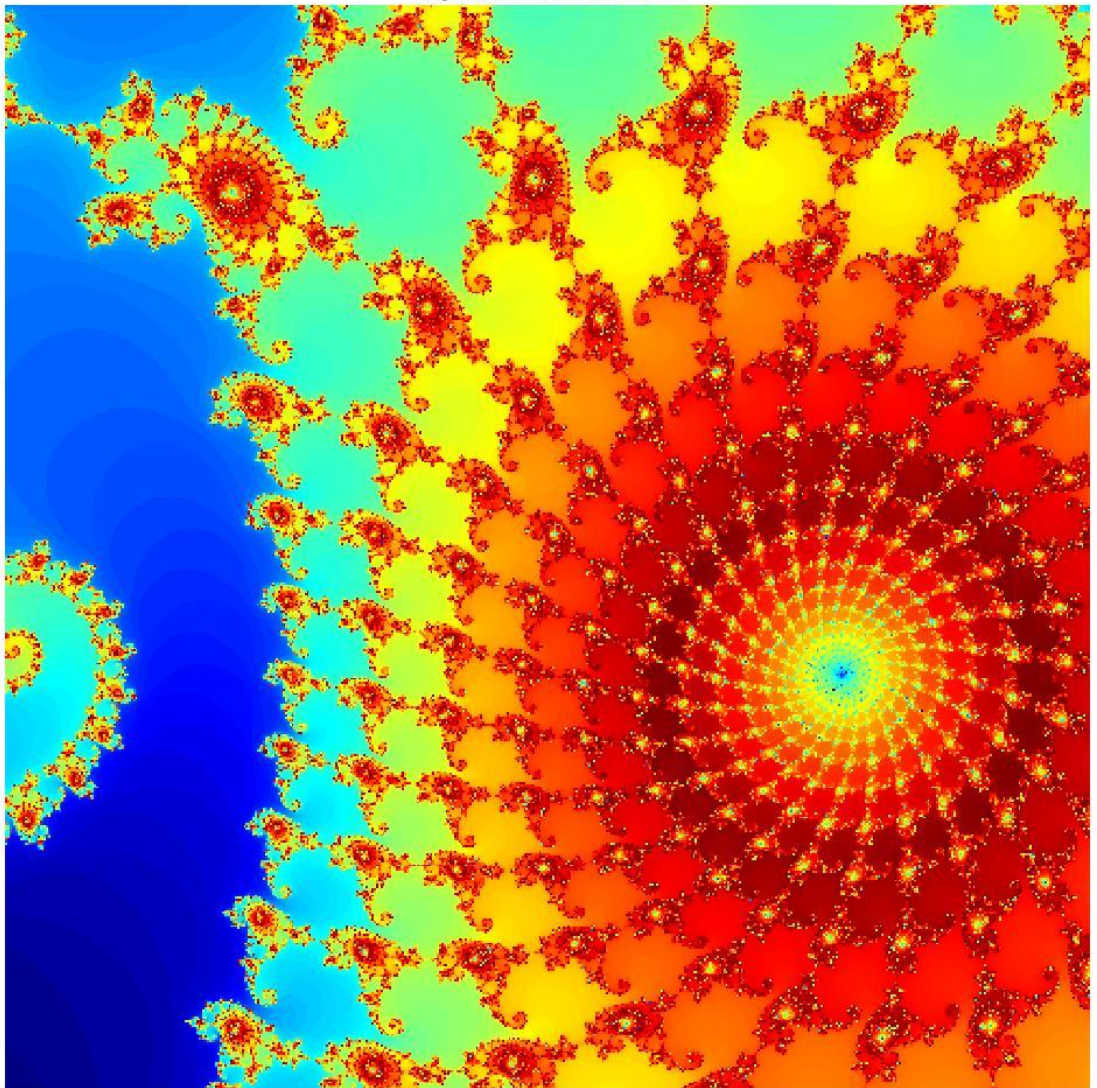


Elapsed time: 6.77secs



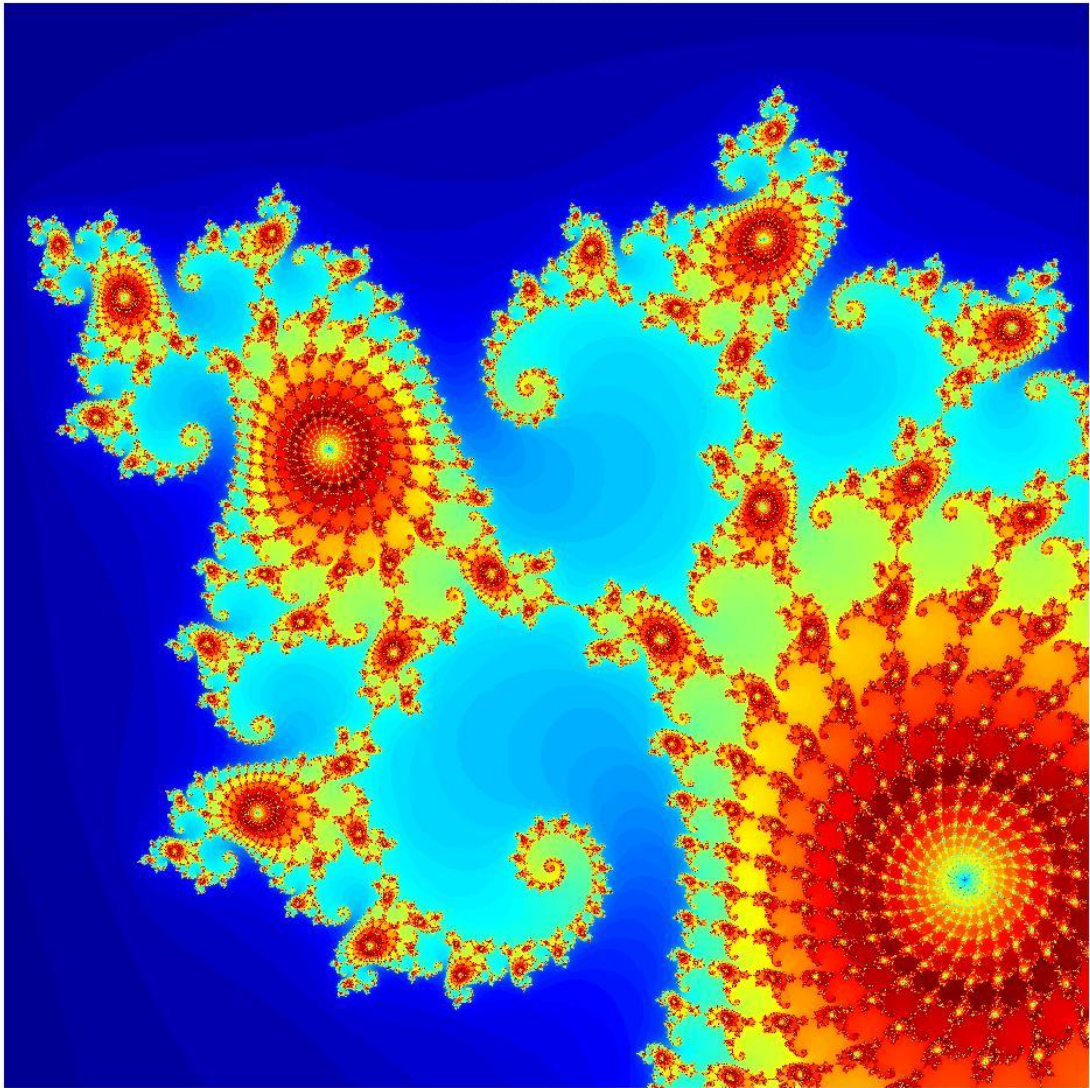


Elapsed time: 7.09secs



Combined Image

Elapsed time: 6.67secs





## Code (Number of Workers = 4) (2000x2000 Grid Domain) (Method 1)

```
clear;

% Starting 4 workers

if isempty(gcp())
    parpool(4);
end

maxIterations = 2000; gridSize = 2000;

xlim = [-0.748766713922161, -0.748766707771757];
ylim = [ 0.123640844894862, 0.123640851045266];

% Creating 2000x2000 grid domain

x = linspace(xlim(1),xlim(2),gridSize);
y = linspace(ylim(1),ylim(2),gridSize);

% Partitioning into 2x2 square blocks of 1000x1000 grid points each

lp1 = [0,0,0,0,1000,1000,1000,1000];
lp2 = [0,0,1000,1000,0,0,1000,1000];

% Each worker do a square block

tic();
spmd
    m = labindex()*2;
    n = m-1;
    [xGrid,yGrid] = meshgrid(x(1+lp1(n):1000+lp1(m)),y(1+lp2(n):1000+lp2(m)));
    z0 = xGrid + 1i*yGrid;

    count = ones(size(z0));
    z = z0;

    for n = 0:maxIterations
        z = z.*z + z0;
        inside = abs(z)<=2;
        count = count + inside;
    end
    count = log(count);
end
cpuTime = toc();

set(gcf, 'Position', [200 200 600 600] );

% Concatenate all square blocks to a single 2000x2000 grid

count1 = cat(2,count{1},count{3});
count2 = cat(2,count{2},count{4});
imagesc(x,y,cat(1,count1,count2));

% Display the image

axis image; axis off;
colormap([jet();flipud(jet());0 0 0]); drawnow;
title(sprintf('Elapsed time: %1.2fsecs ',cpuTime));
```

## Code (Number of Workers = 4) (2000x2000 Grid Domain) (Method 2)

```
clear; close all;
if isempty(gcp())
    parpool(4);
end
nworkers = gcp().NumWorkers;
maxIterations = 2000; gridSize = 2000;
xlim = [-0.748766713922161, -0.748766707771757];
ylim = [ 0.123640844894862, 0.123640851045266];
xlim = linspace(xlim(1),xlim(end),nworkers/2+1);
ylim = linspace(ylim(1),ylim(end),nworkers/2+1);
tic();
spmd
    l = labindex();
    if l==1; m=1; n=1; elseif l==2; m=1;n=2; elseif l==3; m=2;n=1; else; m=2;n=2; end
    x = linspace(xlim(m),xlim(m+1),gridSize/numlabs()*2);
    y = linspace(ylim(n),ylim(n+1),gridSize/numlabs()*2);
    [xGrid,yGrid] = meshgrid(x,y);
    z0 = xGrid + 1i*yGrid;
    count = ones(size(z0));
    z = z0;
    for n = 0:maxIterations
        z = z.*z + z0;
        inside = abs( z )<=2; count = count + inside;
    end
    count = log(count);
end
cpuTime = toc();
set( gcf, 'Position', [200 200 600 600] );
count1 = cat(2,count{1},count{3});
count2 = cat(2,count{2},count{4});
imagesc(cat(1,count1,count2));
axis image; axis off; colormap([jet();flipud(jet());0 0 0]); drawnow;
title( sprintf('Elapsed Time: %1.2fsecs',cpuTime));
```

Combined Image

Elapsed time: 55.58secs

