



INDIAN INSTITUTE OF TECHNOLOGY  
KHARAGPUR

APPLIED COMPUTATIONAL METHODS LABORATORY

Lab -5

Rajiv Harlalka

20MA20073

Department of Mathematics

# Gauss Seidel Method Without red black coloring

Code:

```
% Main program for the solution of Poisson's equation
% Laplace U = f on 2D using iterative Gauss-Seidel Method
% with Red-Black ordering Version I
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
close all
clc
clear
clf

n=20;
a_amp=7;
f_amp=1;
x_0=0; y_0 = 0.5; c_x = 1; c_y=1;
h=1/(n-1);

% =====
% Compiling all matrices and vectors
% =====

S=DiscretePoisson2D(n);

% Generate coefficient matrix of a((x-1), (x-2), j) = a((h, j)+h)
G=zeros(n,n);
for i=1:n
    for j=1:n
        G(i,j)=1+a_amp*exp(-(((h-x_0)^2)/(2*c_x^2)+(j*y_0)^2/(2*c_y^2)));
    end
end

% Create diagonal matrix from c
D=zeros(n^2,n^2);
for i=1:n
    for j=1:n
        D(j+n*(i-1),j+n*(i-1)) = G(i,j);
    end
end

% If f is one
% f = f_amp * ones(n^2, 1);

% If f is Gaussian function
f=zeros(n^2,1);
for i=1:n
    for j=1:n
        f(n*(i-1)+j) = f_amp*exp(-(((h-x_0)^2)/(2*c_x^2)+(j*y_0)^2/(2*c_y^2)));
    end
end

b=zeros(n^2,1);
for i=1:n
    for j=1:n
        b(n*(i-1)+j)=h^2*(f(n*(i-1)+j))/G(i,j);
    end
end

% Poisson2D Gauss-Seidel RedBlack (Version I)

err = 1; k=0; tol=10^-6;
V=zeros(n,n); V_old=zeros(n,n); F=vec2mat(b,n);
X=log(ones(1,n-1),-1); X = X*X';
blackIndex=invh1b(n)=0;
redIndex=1;
B=V;
V(redIndex)=0;
F=V;
V(blackIndex)=0;
redIndex=1;
red(blackIndex)=0;
black=F;
black(redIndex)=0;
while(err>tol)
    B=X*B+B*(X-h^2*redF)/4;
    B=X*B+B*(X-h^2*blackF)/4;
    k=k+1;
    V_new=B+B;
    err=norm(V_new-V_old);
    V_old=V_new;
end
V_new=[zeros(1,n-2);zeros(n,1);zeros(1,n-2)];
disp('-----Number of iterations in Gauss-Seidel method without redblack ordering-----')
k
x1=0:h:1; y1=0:h:1;
subplot(1,2,1)
surf(x1,y1,V_new)
view(2)
colorbar
xlabel('x_1')
ylabel('y_1')
zlabel('u(x_1,x_2)')
title(['Solution u(x_1,x_2) Gauss-Seidel Red-Black ordering, version I ', ...
    ', N = ', num2str(n), ', iter = ', num2str(k)])

subplot(1,2,2)
surf(x1,y1,V_new)
colorbar
xlabel('x_1')
ylabel('y_1')
zlabel('u(x_1,x_2)')
title(['Solution u(x_1,x_2) Gauss-Seidel Red-Black ordering, version I ', ...
    ', N = ', num2str(n), ', iter = ', num2str(k)])
```

Output

-----Number of iterations in Gauss-Seidel method without redblack ordering-----

k = 665

## Code

```
% Main program for the solution of Poisson's equation
% Laplace U = f in 2D using iterative Gauss - Seidel Method
% With Red-Black ordering, version 1
%*****
clear all
clc
clear
clf

n=20;
a_omp=12;
f_omp=1;
x_omp=1; y_omp=0; b_omp=1; c_x_omp=1; c_y_omp=1;
h=1/(n+1);

%*****
% Computing all matrices and vectors
%*****

%DiscretePoisson2D(n);

% generate coefficient matrix of a((x+1,1), (x,2)) = a((x,y), (y))
%zeros(n,n);
for i=1:n
    for j=1:n
        C(i,j)=1+a_omp*exp(-((1+h-x_omp)*h)^2/(2*c_x_omp^2)+(1+h-y_omp)*h^2/(2*c_y_omp^2)));
    end
end

% Create diagonal matrix from c
D=zeros(n^2,n^2);
for i=1:n
    for j=1:n
        D((j+n*(i-1)),j+n*(i-1)) = C(i,j);
    end
end

% If T is Gauss
% T = f_omp + zeros(n^2, 1);

% If T is Gaussian function
%zeros(n^2,1);
for i=1:n
    for j=1:n
        f((n-1)*j+1) = f_omp*exp(-((1+h-x_omp)*h)^2/(2*c_x_omp^2)+(1+h-y_omp)*h^2/(2*c_y_omp^2)));
    end
end

b=zeros(n^2,1);
for i=1:n
    for j=1:n
        b((n-1)*j+1)=b^2*(f((n-1)*j+1))/C(i,j);
    end
end

% Poisson2D_Gauss-Seidel RedBlack (Version1)

err = 1e-6;tol=10^(-5);
%zeros(n,n);%old=zeros(n,n);fvec=2*b(n,n');
%diag(ones(1,n-1), 1); X = X\K';
blackindex=invhblb(n);
redindex=fliplr(blackindex);
bw=[];
V(redindex)=0;
nV=2;
V(blackindex)=0;
redid=[];
redf(blackindex)=0;
blackid=[];
blackf(redindex)=0;
while(err>tol)
    B=(X+b*B*x+h^2)*redf/d;
    B=(X+B*B*x+h^2)*blackf/d;
    bw=[];
    V_new=B*B;
    err=norm(V_new-V_old);
    V_old=V_new;
end
V_new=zeros(1,n+1);zeros(n,1) V_new zeros(n,1);zeros(1,n+1);
disp('-----Number of iterations in Gauss-Seidel method with redblack ordering-----')
x=[];y=[];
subplot(1,1,1)
surf(x(1),y(1),V_new)
view(2)
colorbar
xlabel('x,1')
ylabel('y,1')
zlabel('u(x,1,x,2)')
title('Solution of u(x,1,x,2) Gauss-Seidel Red-Black ordering, version 1', ...
'k', 'k', 'num2str(n)', 'Iter = ', num2str(k))

subplot(1,1,2)
surf(x(1),y(1),V_new)
colorbar
xlabel('x,1')
ylabel('y,1')
zlabel('u(x,1,x,2)')
title('Solution of u(x,1,x,2) Gauss-Seidel Red-Black ordering, version 1', ...
'k', 'k', 'num2str(n)', 'Iter = ', num2str(k))
```

Output:

-----Number of iterations in Gauss-Seidel method with redblack ordering-----

k = 363

## Code

[illegible]

Output:

```
-- Number of iterations in the version II of Gauss-Seidel method-----
```

k = 363