COMPUTING REPORT 6 MACM 316

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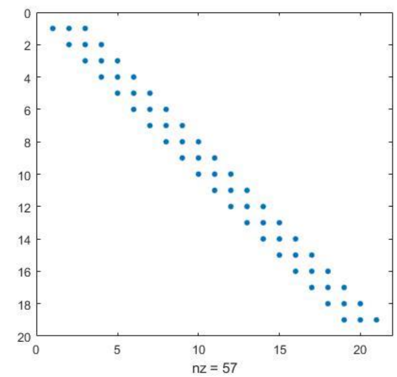
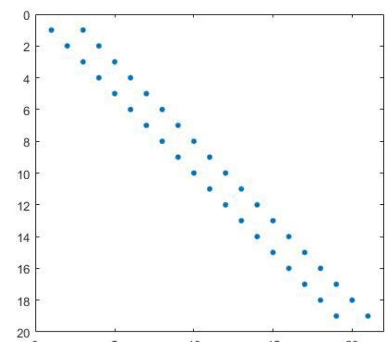
a) To compute the 2nd order formula, I first generated the matrices A and B as described in the guideline. Their plots are on the right.



Plot of Matrix A

These matrices resemble tridiagonal matrices except the fact that they are non-square with dimensions of (n-1) by (n+1), possibly to accommodate the two endpoints into the calculation of the middle points.



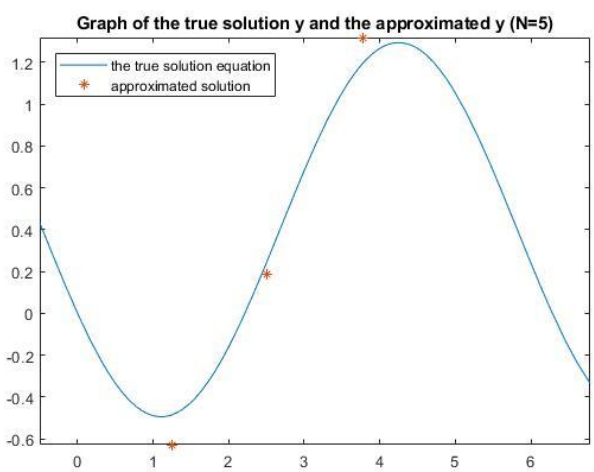
Plot of Matrix B

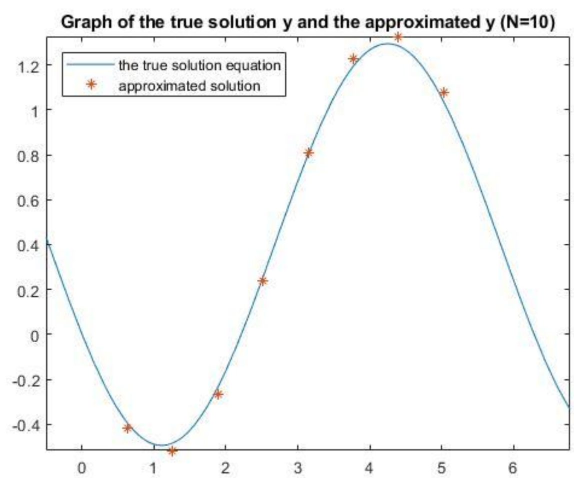
Then I used A and B and the approximated equations for y' and y'' to obtain the matrix C as follows:

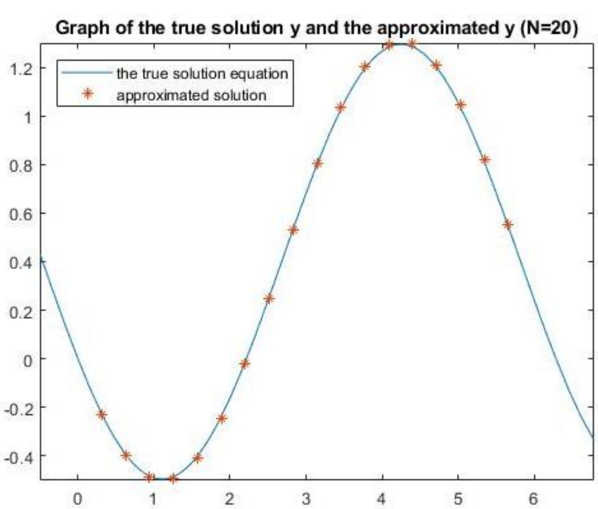
$$C=\left(\frac{1}{h^2}\right)A\ +0.5\left(\frac{1}{2h}\right)B \quad \text{then, } Cy(x)=\sin(x).$$

Using the backslash command gives me the approximated values of y(x) at points on the grid.

These are the approximated y for values of N=5,10,20 (without the two endpoints of 0):







As expected, the values of the errors decrease as N increases.

```
%Computing Assignment 6
%MACM 316 Spring 2018
```

```matlab
%Numerical Differentiation
n=20;
A=zeros(n-1,n+1);
B=zeros(n-1,n+1);
sinx=zeros(n-1,1);
dy=zeros(n,1);
ddy=zeros(n,1);
x=zeros(n-1,1);
step=2*pi/n;
ogx=zeros(n+1,1);

%Generate A and B matrices
k=1;
i=1;
while i<n
    B(i,k)=-1;
    B(i,k+2)=1;
    A(i,k)=1;
    A(i,k+1)=-2;
    A(i,k+2)=1;
    k=k+1;
    i=i+1;
end

%Generating grid points x
i=1;
while i<(n)
    ogx(i+1)=step*i;
    x(i)=step*i;
    i=i+1;
end

%Compute sin(x) at grid points x
i=1;
while i<n
    sinx(i)=sin(x(i));
    i=i+1;
end

%Calculating dy and ddy
dy=(1/(2*step))*B;
ddy=(1/(step^2))*A;

%C=ddy+0.5*dy
C=ddy+0.5*dy;

%Computing y(xi)
y=C\sinx;

%computing true values
tru=@(t) 0.4*(1-cos(t))-0.8*sin(t);
fplot(tru, [-0.5 2*pi+0.5])
title('Graph of the true solution y and the approximated y (N=20)')
hold on
plot(ogx(2:n-1),y(2:n-1) ,'*')
legend('the true solution equation','approximated solution', 'Location', 'northwest')
```