hmwk3_p1

March 19, 2018

1 Homework 3 - Problem 1

```
In [1]: %matplotlib inline
        import numpy as np
        import matplotlib.pyplot as plt
        import pandas as pd
        import subprocess
```

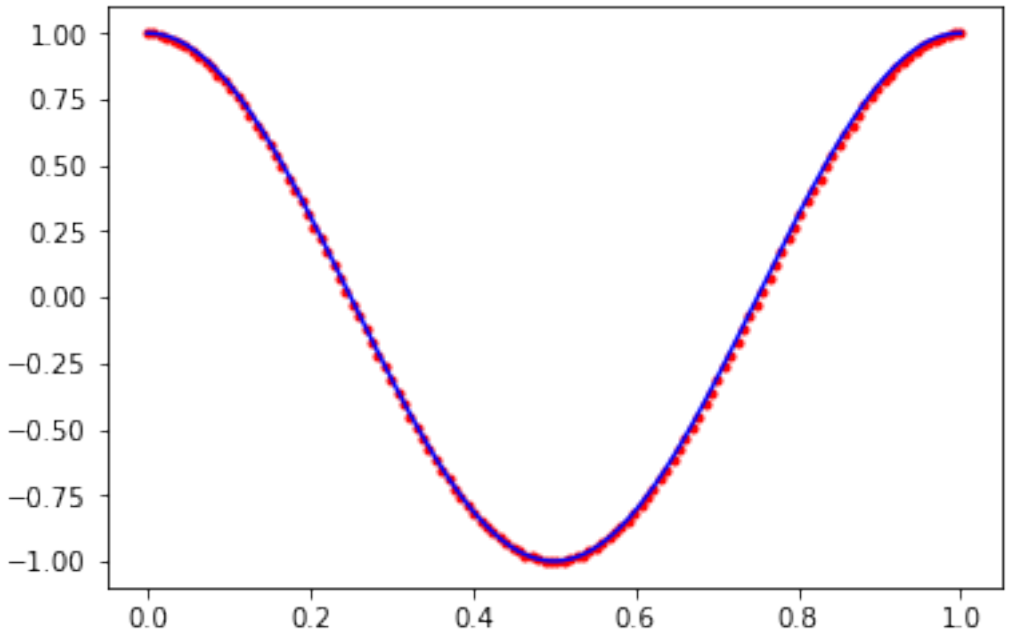
2 Parts (a & b)

```
In [2]: %%bash
        mpirun -n 1 hmwk3_1c -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1c.csv
```

```
In [3]: A = np.genfromtxt('hmwk3_1c.csv', delimiter=',')
        print("iterations: %d" % A[-3])
        print("residual: %g" % A[-2])
        print("error: %g" % A[-1])
        A = A[:-3]
        print("cells: %d" % len(A))
        x = np.linspace(0,1,len(A))
        plt.plot(x,A,'r.')
        plt.plot(x, np.cos(2*np.pi*x), 'b-')
```

```
iterations: 46678
residual: 9.9997e-11
error: 0.000301185
cells: 128
```

```
Out[3]: [<matplotlib.lines.Line2D at 0x7fea35616550>]
```

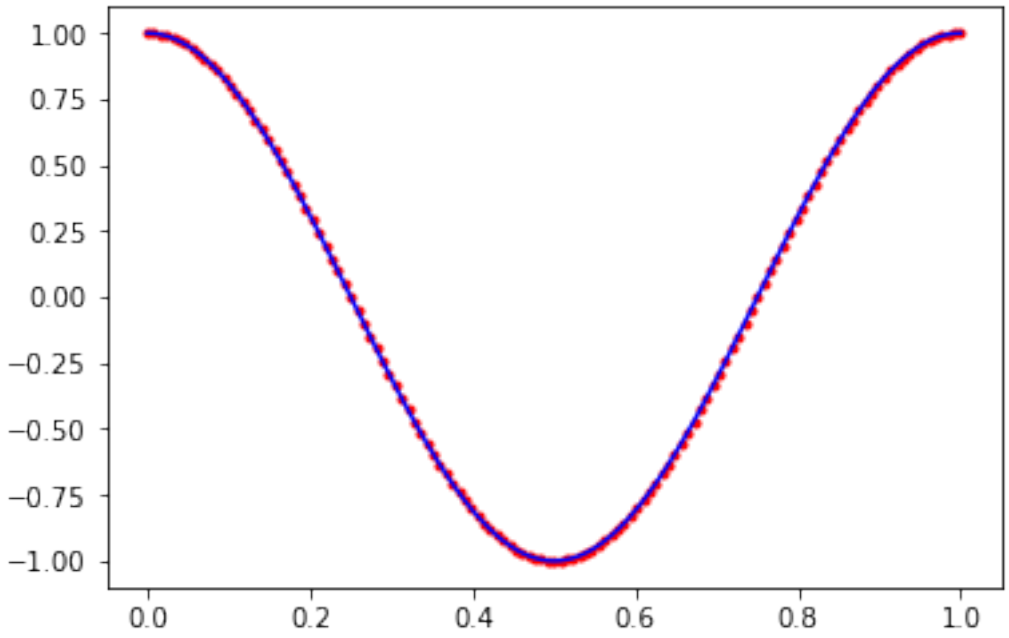



```
In [4]: %%bash
        mpirun -n 1 hmwk3_1n -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1n.csv
```

```
In [5]: A = np.genfromtxt('hmwk3_1n.csv', delimiter=',')
        print("iterations: %d" % A[-3])
        print("residual: %g" % A[-2])
        print("error: %g" % A[-1])
        A = A[:-3]
        print("nodes: %d" % len(A))
        x = np.linspace(0,1,len(A))
        plt.plot(x,A,'r.')
        plt.plot(x, np.cos(2*np.pi*x), 'b-')
```

```
iterations: 51284
residual: 9.99849e-11
error: 0.000401561
nodes: 129
```

```
Out[5]: [<matplotlib.lines.Line2D at 0x7fea64e63860>]
```




```
In [6]: %%bash
        mpirun -n 1 hmwk3_1c -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1c_1.csv

In [7]: %%bash
        mpirun -n 2 hmwk3_1c -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1c_2.csv

In [8]: %%bash
        mpirun -n 4 hmwk3_1c -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1c_4.csv

In [9]: data = {}
        columns = ['Processes', 'iterations', 'residual', 'error']
        df = pd.DataFrame(columns=columns)
        for n in [1,2,4]:
            A = np.genfromtxt('hmwk3_1c_' + str(n) +'.csv', delimiter=',')
            iterations = A[-3]
            residual = A[-2]
            error = A[-1]
            A = A[:-3]

            data_row = {'Processes': n, 'iterations': iterations, 'residual': residual, 'error':
            df = df.append(pd.Series(data=data_row, name=str(n)))
        print(df)
```

```
   Processes  iterations      residual     error
1        1.0     46678.0  9.999701e-11  0.000301
2        2.0     46678.0  9.999701e-11  0.000301
4        4.0     46678.0  9.999701e-11  0.000301
```

```
In [10]: %%bash
         mpirun -n 1 hmwk3_1n -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1n_1.csv

In [11]: %%bash
         mpirun -n 2 hmwk3_1n -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1n_2.csv

In [12]: %%bash
         mpirun -n 4 hmwk3_1n -n 128 --itermax 100000 --tol 1e-10 > hmwk3_1n_4.csv

In [13]: data = {}
         columns = ['Processes', 'iterations', 'residual', 'error']
         df = pd.DataFrame(columns=columns)
         for n in [1,2,4]:
             A = np.genfromtxt('hmwk3_1n_' + str(n) +'.csv', delimiter=',')
             iterations = A[-3]
             residual = A[-2]
             error = A[-1]
             A = A[:-3]

             data_row = {'Processes': n, 'iterations': iterations, 'residual': residual, 'error'
             df = df.append(pd.Series(data=data_row, name=str(n)))
         print(df)
```

```
   Processes  iterations      residual     error
1        1.0     51284.0  9.998491e-11  0.000402
2        2.0     45382.0  9.997070e-11  0.075500
4        4.0     43679.0  9.997869e-11  0.123373
```

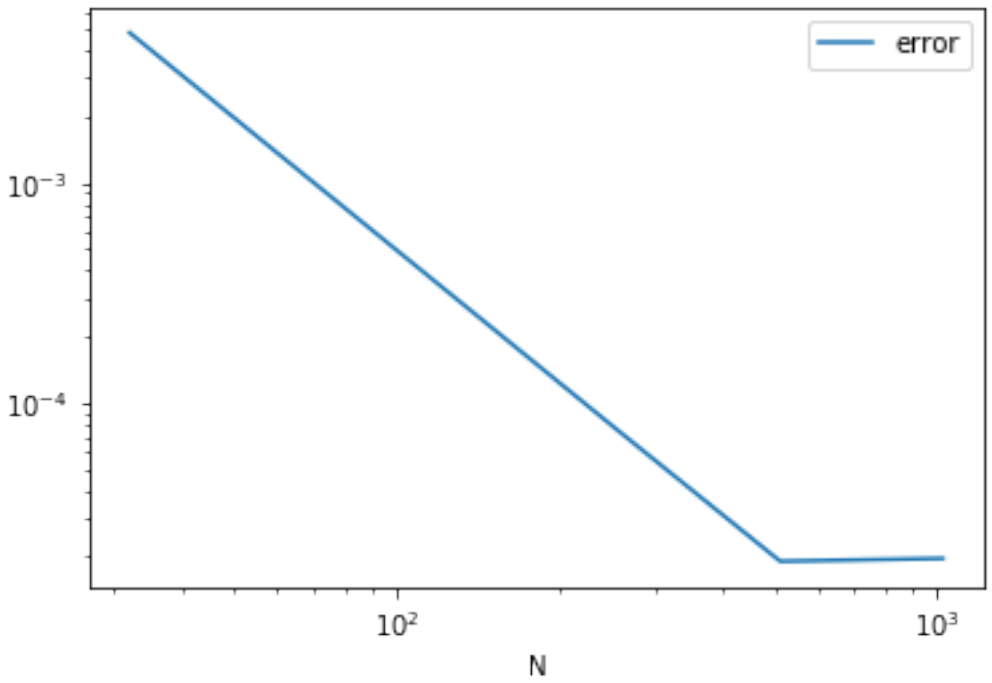
3 Part (c)

```
In [14]: %%bash
         mpirun -n 1 hmwk3_1c -n 32 --itermax 10000000 --tol 1e-10 > hmwk3_1c_N32.csv

In [15]: %%bash
         mpirun -n 1 hmwk3_1c -n 64 --itermax 10000000 --tol 1e-10 > hmwk3_1c_N64.csv

In [16]: %%bash
         mpirun -n 1 hmwk3_1c -n 128 --itermax 10000000 --tol 1e-10 > hmwk3_1c_N128.csv

In [17]: %%bash
         mpirun -n 1 hmwk3_1c -n 256 --itermax 10000000 --tol 1e-10 > hmwk3_1c_N256.csv

In [18]: %%bash
         mpirun -n 1 hmwk3_1c -n 512 --itermax 1000000000 --tol 1e-10 > hmwk3_1c_N512.csv

In [19]: %%bash
         mpirun -n 1 hmwk3_1c -n 1024 --itermax 1000000000 --tol 1e-10 > hmwk3_1c_N1024.csv
```

In [20]:
```
data = {}
columns = ['N', 'iterations', 'residual', 'error']
df = pd.DataFrame(columns=columns)
for n in [32,64,128,256,512,1024]:
    A = np.genfromtxt('hmwk3_1c_N' + str(n) + '.csv', delimiter=',')
    iterations = A[-3]
    residual = A[-2]
    error = A[-1]
    A = A[:-3]

    data_row = {'N': (n), 'iterations': iterations, 'residual': residual, 'error':error
    df = df.append(pd.Series(data=data_row, name=str(n)))
print(df)
df.plot(x='N', y='error', loglog=True)
```

	N	iterations	residual	error
32	32.0	3487.0	9.969658e-11	0.004815
64	64.0	12816.0	9.990297e-11	0.001205
128	128.0	46678.0	9.999701e-11	0.000301
256	256.0	168320.0	9.999890e-11	0.000075
512	512.0	599655.0	9.999979e-11	0.000019
1024	1024.0	2104071.0	9.999990e-11	0.000020

Out[20]: <matplotlib.axes._subplots.AxesSubplot at 0x7fea2cd23160>



In [21]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 32 --itermax 10000000 --tol 1e-10 > hmwk3_1n_N32.csv
```

In [22]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 64 --itermax 10000000 --tol 1e-10 > hmwk3_1n_N64.csv
```

In [23]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 128 --itermax 10000000 --tol 1e-10 > hmwk3_1n_N128.csv
```

In [24]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 256 --itermax 10000000 --tol 1e-10 > hmwk3_1n_N256.csv
```

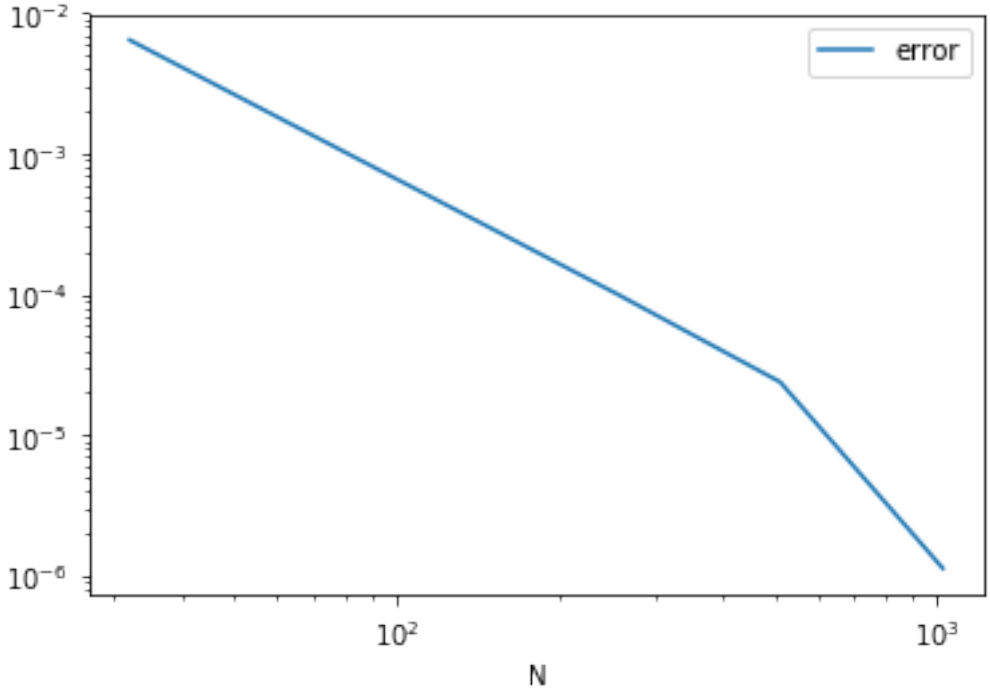
In [25]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 512 --itermax 1000000000 --tol 1e-10 > hmwk3_1n_N512.csv
```

In [26]:
```
%%bash
mpirun -n 1 hmwk3_1n -n 1024 --itermax 1000000000 --tol 1e-10 > hmwk3_1n_N1024.csv
```

In [27]:
```
data = {}
columns = ['N', 'iterations', 'residual', 'error']
df = pd.DataFrame(columns=columns)
for n in [32,64,128,256,512,1024]:
    A = np.genfromtxt('hmwk3_1n_N' + str(n) + '.csv', delimiter=',')
    iterations = A[-3]
    residual = A[-2]
    error = A[-1]
    A = A[:-3]

    data_row = {'N': (n), 'iterations': iterations, 'residual': residual, 'error':error
    df = df.append(pd.Series(data=data_row, name=str(n)))
print(df)
df.plot(x='N', y='error', loglog=True)
```

```
            N  iterations      residual     error
32       32.0      3778.0  9.935863e-11  0.006438
64       64.0     13970.0  9.984347e-11  0.001607
128     128.0     51284.0  9.998491e-11  0.000402
256     256.0    186734.0  9.999512e-11  0.000100
512     512.0    673302.0  9.999646e-11  0.000024
1024   1024.0   2398640.0  9.999901e-11  0.000001
```

Out[27]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fea2cd35550>
```


error
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{2}
10^{3}
N