Algorithm Assignment 1

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1 Write a program to multiply two matrices of NxN using nave algorithm

```
# /usr/bin/python

from gmpy import mpq,mpz
from random import randint,seed
from time import time

def rand_matrix(n, typ=int, N=10):
   ''' A function to matrix with random elements '''

   m = []
   for i in range(n):
      a = []

      for j in range(n):
         p = randint(0, N)
         a.append(p)

      m.append(a)
   return m

def matrixmult (A, B):
   ''' A function to do normal matrix multiplication '''

   rows_A = len(A)
   cols_A = len(A[0])
   rows_B = len(B)
   cols_B = len(B[0])

   if cols_A != rows_B:
     print "Cannot multiply the two matrices. Incorrect
        dimensions."
```

```
    return

  # Create the result matrix
  # Dimensions would be rows_A x cols_B
  C = [[0 for row in range(cols_B)] for col in range(rows_A)]

  for i in range(rows_A): # C * n
     for j in range(cols_B): # C * n * n
        for k in range(cols_A): # C * n * n
           C[i][j] += A[i][k]*B[k][j]
  return C

def test_1(N):
  seed(2)
  for n in range(100, 1000, 100):
     a = rand_matrix(n, mpq, N)
     b = rand_matrix(n, mpq, N)
     t0 = time()
     C = matrixmult(a, b)
     t1 = time()

     print 'dimension: %d traditional way: %.2f' %(n, t1-t0)

test_1(1000000)
```

Time complexity: $O(n^3)$

2 Strassen multiplication Algorithm

```
# /usr/bin/python

from gmpy import mpq,mpz
from random import randint,seed
from time import time

def rand_matrix(n, typ=int, N=10):
  ''' A function to matrix with random elements '''

  m = []
  for i in range(n):
     a = []

     for j in range(n):
        p = randint(0, N)
        a.append(p)
```

```
        m.append(a)
    return m

def madd(a, b):
    ''' A function to add two matrices '''

    n = len(a)
    c = []

    for i in range(n):
        c.append(a[i][:])

    for i in range(n):
        c1 = c[i]
        b1 = b[i]

        for j in range(n):
            c1[j] += b1[j]

    return c


def imadd(a, b):
    ''' A function to '''

    n = len(a)
    for i in range(n):
        a1 = a[i]
        b1 = b[i]

        for j in range(n):
            a1[j] += b1[j]

    return a

def msub(a, b):
    ''' A function to substract two matrices '''

    n = len(a)
    c = []
    for i in range(n):
        c.append(a[i][:])

    for i in range(n):
        c1 = c[i]
        b1 = b[i]
        for j in range(n):
            c1[j] -= b1[j]

    return c
```

```
def imsub(a, b):
   ''' A function to substract two matrices'''

   n = len(a)
   for i in range(n):
      a1 = a[i]
      b1 = b[i]
      for j in range(n):
         a1[j] -= b1[j]
   return a

def mmul(a, b):
   ''' A function to multiply two matrices in a traditional
       way '''

   n = len(a)
   c = []

   for i in range(n):
      cv = []
      a1 = a[i]

      for j in range(n):
         r = 0

         for k in range(n):
            r += a1[k] * b[k][j]

         cv.append(r)
      c.append(cv)
   return c

def mmul(a, b, trans=0):
   ''' A function to multiply transitive matrices '''

   n = len(a)
   c = []
   if not trans:
      bt = [[0]*n for _ in range(n)]

      for i in range(n):
         for j in range(n):
            bt[i][j] = b[j][i]

      b = bt

   for i in range(n):
      a1 = a[i]
      cv = []
```

```
      for j in range(n):
         b1 = b[j]
         r = 0
         for k in range(n):
            r += a1[k]*b1[k]
         cv.append(r)
      c.append(cv)
   return c

def strassen_mul(a,b,trans=0):
   ''' Strassem multiply implementation '''

   n = len(a)
   if n % 2 == 1 or n <= 128:
      return mmul(a,b,trans)

   rn0 = range(n/2)
   rn1 = range(n/2, n)
   A00 = [a[i] [:n/2] for i in rn0]
   A01 = [a[i] [n/2:] for i in rn0]
   A10 = [a[i] [:n/2] for i in rn1]
   A11 = [a[i] [n/2:n] for i in rn1]

   if trans:
      B00 = [b[i] [:n/2] for i in rn0]
      B10 = [b[i] [n/2:] for i in rn0]
      B01 = [b[i] [:n/2] for i in rn1]
      B11 = [b[i] [n/2:n] for i in rn1]

   else:
      B00 = [[b[j][i] for j in rn0] for i in rn0]
      B01 = [[b[j][i] for j in rn0] for i in rn1]
      B10 = [[b[j][i] for j in rn1] for i in rn0]
      B11 = [[b[j][i] for j in rn1] for i in rn1]

   M1 = strassen_mul(madd(A00, A11), madd(B00, B11), 1)
   M2 = strassen_mul(madd(A10, A11), B00, 1)
   M3 = strassen_mul(A00, msub(B01, B11), 1)
   M4 = strassen_mul(A11, msub(B10, B00), 1)
   M5 = strassen_mul(madd(A00, A01), B11, 1)
   M6 = strassen_mul(msub(A10, A00), madd(B00, B01), 1)
   M7 = strassen_mul(msub(A01, A11), madd(B10, B11), 1)
   C00 = madd(msub(madd(M1, M4), M5), M7)
   C01 = madd(M3, M5)
   C10 = madd(M2, M4)
   C11 = madd(madd(msub(M1, M2), M3), M6)
   c = [C00[i] + C01[i] for i in rn0]
   for i in rn0:
      c.append(C10[i] + C11[i])
   return c
```

```
def test_1(N):
   seed(2)
   for n in range(100, 1000, 100):
      a = rand_matrix(n, mpq, N)
      b = rand_matrix(n, mpq, N)
      t0 = time()
      C = mmul(a, b)
      t1 = time()
      c = strassen_mul(a,b)
      t2 = time()
      assert c == C
      print 'dimension=%d traditional way: %.2f strassen:
          %.2f' %(n, t1-t0, t2-t1)

test_1(1000000)
```

Time complexity: $O(n^{2.807})$

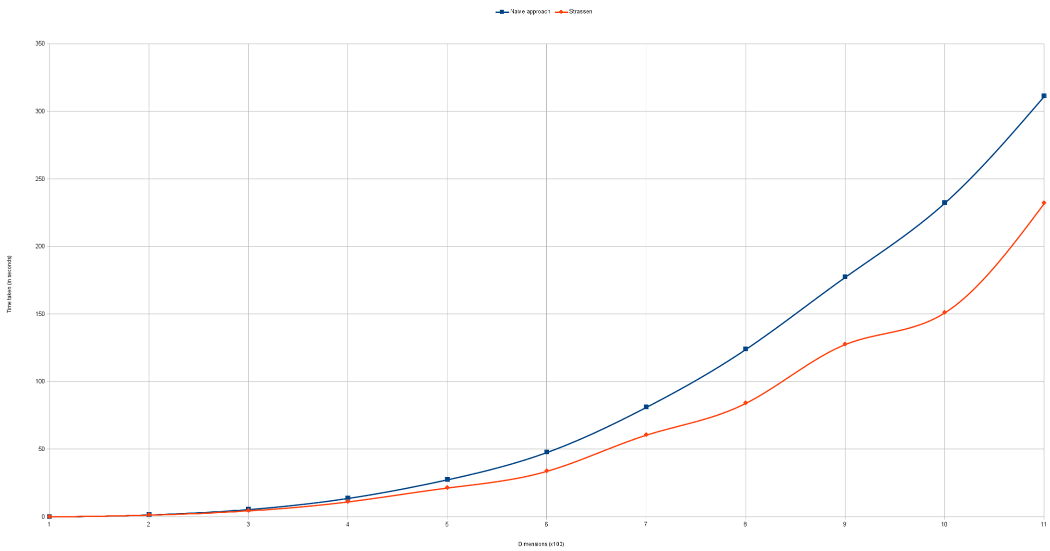
3 Implementation of the program

The implementation of my program is available in my github (under matrix directory) repository.

4 Graph

Input Size	Naive approach	Strassen
100	0	0
100	0.21	0.21
200	1.67	1.56
300	5.64	4.73
400	13.94	11.36
500	27.73	21.64
600	47.96	34.03
700	81.39	60.78
800	124.36	84.36
900	177.66	127.86
1000	232.52	151.30
1100	311.57	232.37

5 Graph



Naive approach
Strassen
350
300
250
200
150
100
50
0
Time taken (in seconds)
1
2
3
4
5
6
7
8
9
10
11
Dimensions (x100)