Sorted

November 24, 2020

To compare the time required to sort different types of list of different lengths

Step 0 : Importing essential libraries

[1]:
```
import timeit
import matplotlib.pyplot as plt
import random
```

Step 1 : Defining our functions

Step 1.1 : Defining a Time function

[2]:
```
#Function to check for time-taken
def time(com):
    return timeit.timeit(com, number=1, globals=globals())
```

Step 1.2 : Defining the sorting algorithms

1. Insert Sort

[3]:
```
def insert_sort(arr):
    for i in range(1, len(arr)):
        x = arr[i]
        j = i - 1
        while j >= 0 and (x< arr[j]):
            arr[j + 1] = arr[j]
            j = j - 1
        arr[j + 1] = x
    return arr
```

[4]:
```
insert_sort([6,5,5,4,2,1])
```

[4]:
```
[1, 2, 4, 5, 5, 6]
```

2. Merge Sort

[5]:
```
def merge(a,b):
    d = [None for x in range(0,len(b) + len(a))]
    i =0
    j =0
    for k in range(0,len(d)):
```

```
        if i>=len(a) :
            d[k] = b[j]
            j=j+1
            continue
        if j>=len(b) :
            d[k] = a[i]
            i=i+1
            continue
        if a[i] < b[j] :
            d[k] = a[i]
            i = i+1
        else:
            d[k] = b[j]
            j = j+1
    return d

def merge_sort(A,m,n):
    if (n-m)  == 1:
        return [A[m]]
    else:
        p =(m+n)//2
        B = merge_sort(A,m,p)
        C = merge_sort(A,p,n)
        D = merge(B,C)
        return D

def merge_sort_all(A):
    return merge_sort(A,0,len(A))
```

[6]:
```
merge_sort_all([6,5,5,4,2,1])
```

[6]:
```
[1, 2, 4, 5, 5, 6]
```

3. Bubble Sort

[7]:
```
def bub_sort(arr):
    ctr = 0
    for i in range(0,len(arr)-1):
        for j in range(0,len(arr)-i-1):
            if arr[j]>arr[j+1]:
                ctr =ctr + 1
                arr[j],arr[j+1]=arr[j+1],arr[j]
        if ctr == 0 : break
    return arr
```

[8]:
```
bub_sort([5,41,1,5,6,8,2,3])
```

[8]:
```
[1, 2, 3, 5, 5, 6, 8, 41]
```

Step 1.3 : Defining the list generation algorithms

[9]:
```
# Returns a sorted array
def gen_sort_list(length):
    return [i for i in range(length)]
```

[10]:
```
gen_sort_list(5)
```

[10]:
```
[0, 1, 2, 3, 4]
```

[11]:
```
# Returns a reverse sorted list
def gen_rev_list(length):
    return [(length-i-1) for i in range(length)]
```

[12]:
```
gen_rev_list(5)
```

[12]:
```
[4, 3, 2, 1, 0]
```

[13]:
```
#Returns a randomized list
def gen_rand_list(length):
    return [random.randrange(0,length) for i in range(length)]
```

[14]:
```
gen_rand_list(5)
```

[14]:
```
[1, 3, 0, 4, 4]
```

Step 2 : Generating the strings required for the time function

[15]:
```
'''
Function takes two parameters, number of time strings (eg.␣
 ↪insert_sort("AVBCD")) to and
the function to generate the strings (gen_sort_list or gen_rev_list or␣
 ↪gen_rand_list)
'''
def time_strings(length,gen_list):
    time_insert_strings = ['insert_sort({})'.format(gen_list(i)) for i in␣
 ↪range(1,length+1)]
    time_bub_strings = ['bub_sort({})'.format(gen_list(i)) for i in␣
 ↪range(1,length+1)]
    time_merge_strings = ['merge_sort_all({})'.format(gen_list(i)) for i in␣
 ↪range(1,length+1)]
    lengths = [i+1 for i in range(length)] #x's
    return [time_insert_strings,time_bub_strings,time_merge_strings,lengths]
#time_default_strings = ['insert_sort({})'.format(gen_sort_list(i)) for i in␣
 ↪range(1,100)]
```

[16]:
```
time_strings(10,gen_sort_list)
```

[16]:
```
[['insert_sort([0])',
  'insert_sort([0, 1])',
  'insert_sort([0, 1, 2])',
  'insert_sort([0, 1, 2, 3])',
  'insert_sort([0, 1, 2, 3, 4])',
  'insert_sort([0, 1, 2, 3, 4, 5])',
  'insert_sort([0, 1, 2, 3, 4, 5, 6])',
  'insert_sort([0, 1, 2, 3, 4, 5, 6, 7])',
  'insert_sort([0, 1, 2, 3, 4, 5, 6, 7, 8])',
  'insert_sort([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])'],
 ['bub_sort([0])',
  'bub_sort([0, 1])',
  'bub_sort([0, 1, 2])',
  'bub_sort([0, 1, 2, 3])',
  'bub_sort([0, 1, 2, 3, 4])',
  'bub_sort([0, 1, 2, 3, 4, 5])',
  'bub_sort([0, 1, 2, 3, 4, 5, 6])',
  'bub_sort([0, 1, 2, 3, 4, 5, 6, 7])',
  'bub_sort([0, 1, 2, 3, 4, 5, 6, 7, 8])',
  'bub_sort([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])'],
 ['merge_sort_all([0])',
  'merge_sort_all([0, 1])',
  'merge_sort_all([0, 1, 2])',
  'merge_sort_all([0, 1, 2, 3])',
  'merge_sort_all([0, 1, 2, 3, 4])',
  'merge_sort_all([0, 1, 2, 3, 4, 5])',
  'merge_sort_all([0, 1, 2, 3, 4, 5, 6])',
  'merge_sort_all([0, 1, 2, 3, 4, 5, 6, 7])',
  'merge_sort_all([0, 1, 2, 3, 4, 5, 6, 7, 8])',
  'merge_sort_all([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])'],
 [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]]
```

[17]:
```
time_strings(10,gen_rev_list)
```

[17]:
```
[['insert_sort([0])',
  'insert_sort([1, 0])',
  'insert_sort([2, 1, 0])',
  'insert_sort([3, 2, 1, 0])',
  'insert_sort([4, 3, 2, 1, 0])',
  'insert_sort([5, 4, 3, 2, 1, 0])',
  'insert_sort([6, 5, 4, 3, 2, 1, 0])',
  'insert_sort([7, 6, 5, 4, 3, 2, 1, 0])',
  'insert_sort([8, 7, 6, 5, 4, 3, 2, 1, 0])',
  'insert_sort([9, 8, 7, 6, 5, 4, 3, 2, 1, 0])'],
 ['bub_sort([0])',
```

```
 'bub_sort([1, 0])',
 'bub_sort([2, 1, 0])',
 'bub_sort([3, 2, 1, 0])',
 'bub_sort([4, 3, 2, 1, 0])',
 'bub_sort([5, 4, 3, 2, 1, 0])',
 'bub_sort([6, 5, 4, 3, 2, 1, 0])',
 'bub_sort([7, 6, 5, 4, 3, 2, 1, 0])',
 'bub_sort([8, 7, 6, 5, 4, 3, 2, 1, 0])',
 'bub_sort([9, 8, 7, 6, 5, 4, 3, 2, 1, 0])'],
['merge_sort_all([0])',
 'merge_sort_all([1, 0])',
 'merge_sort_all([2, 1, 0])',
 'merge_sort_all([3, 2, 1, 0])',
 'merge_sort_all([4, 3, 2, 1, 0])',
 'merge_sort_all([5, 4, 3, 2, 1, 0])',
 'merge_sort_all([6, 5, 4, 3, 2, 1, 0])',
 'merge_sort_all([7, 6, 5, 4, 3, 2, 1, 0])',
 'merge_sort_all([8, 7, 6, 5, 4, 3, 2, 1, 0])',
 'merge_sort_all([9, 8, 7, 6, 5, 4, 3, 2, 1, 0])'],
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]]
```

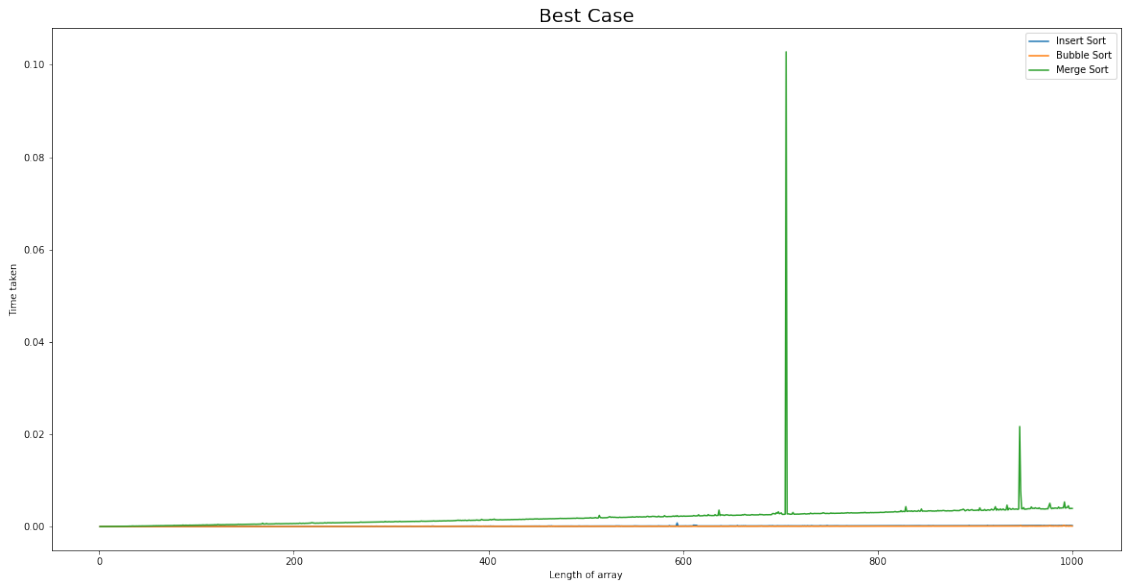
Step 3 : Generating the y's of our plot, that is, the time taken by each algorithm for the best case (sorted list)

[18]:
```
strings = time_strings(1000,gen_sort_list)
time_insert_sort=[time(str) for str in  strings[0]]
time_bub_sort=[time(str) for str in  strings[1]]
time_merge_sort=[time(str) for str in  strings[2]]
lengths = strings[3]
```

Step 3.1 : Plotting the values for the best case

[19]:
```
fig,ax = plt.subplots(figsize=(20,10))
plt.title('Best Case',size=20)
plt.xlabel('Length of array')
plt.ylabel('Time taken')
ax.plot(lengths,time_insert_sort,label='Insert Sort')
ax.plot(lengths,time_bub_sort,label='Bubble Sort')
ax.plot(lengths,time_merge_sort,label='Merge Sort')
ax.legend()
```

[19]:
```
<matplotlib.legend.Legend at 0x7f1249c358d0>
```



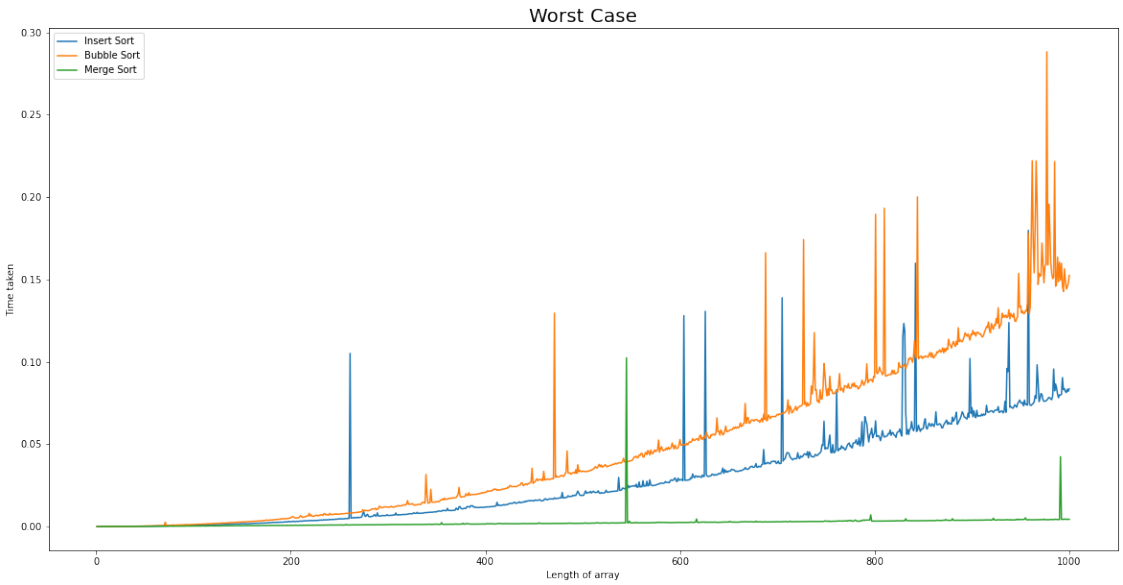
Merge sort performs poorly on the best case as the asymptotic run time lower bound is still O(nlogn) whereas the other sorting methods complete sorting in O(n) time

Step 4 : Generating the y's of our plot, that is, the time taken by each algorithm for the worst case (reverse list)

[20]:
```
strings = time_strings(1000,gen_rev_list)
time_insert_sort=[time(str) for str in  strings[0]]
time_bub_sort=[time(str) for str in  strings[1]]
time_merge_sort=[time(str) for str in  strings[2]]
lengths = strings[3]
```

[21]:
```
fig,ax = plt.subplots(figsize=(20,10))
plt.title('Worst Case',size=20)
plt.xlabel('Length of array')
plt.ylabel('Time taken')
ax.plot(lengths,time_insert_sort,label='Insert Sort')
ax.plot(lengths,time_bub_sort,label='Bubble Sort')
ax.plot(lengths,time_merge_sort,label='Merge Sort')
ax.legend()
```

[21]:
```
<matplotlib.legend.Legend at 0x7f12414a8910>
```

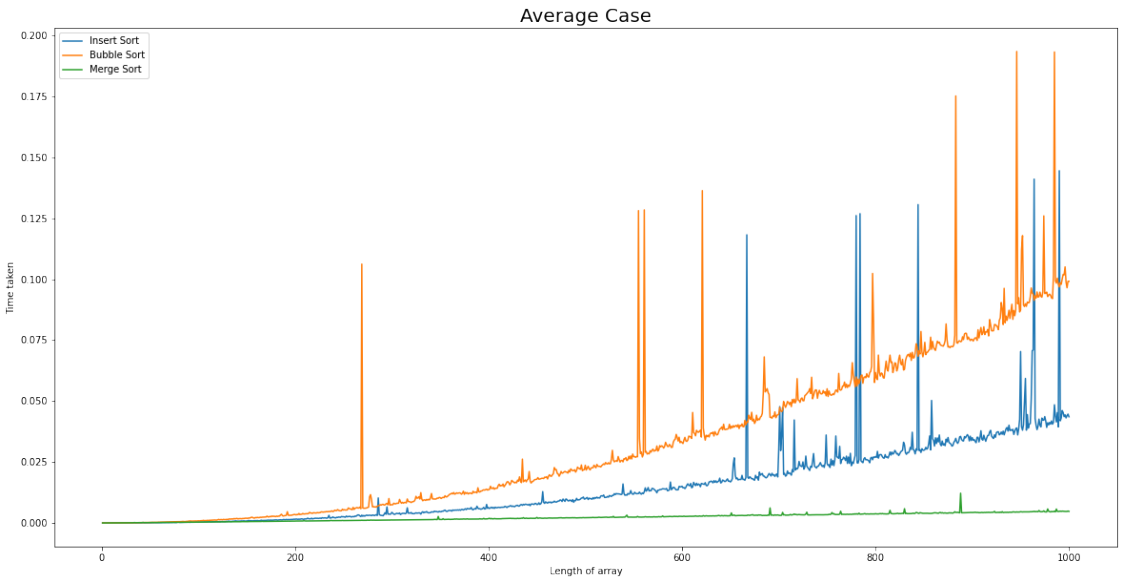


Step 4 : Generating the y's of our plot, that is, the time taken by each algorithm for the average case (random list)

[24]:
```
strings = time_strings(1000,gen_rand_list)
time_insert_sort=[time(str) for str in  strings[0]]
time_bub_sort=[time(str) for str in  strings[1]]
time_merge_sort=[time(str) for str in  strings[2]]
lengths = strings[3]
```

[25]:
```
fig,ax = plt.subplots(figsize=(20,10))
plt.title('Average Case',size=20)
plt.xlabel('Length of array')
plt.ylabel('Time taken')
ax.plot(lengths,time_insert_sort,label='Insert Sort')
ax.plot(lengths,time_bub_sort,label='Bubble Sort')
ax.plot(lengths,time_merge_sort,label='Merge Sort')
ax.legend()
```

[25]:
```
<matplotlib.legend.Legend at 0x7f12413b1850>
```


Average Case
Insert Sort
Bubble Sort
Merge Sort
Time taken
Length of array
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0
200
400
600
800
1000

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[ ]: